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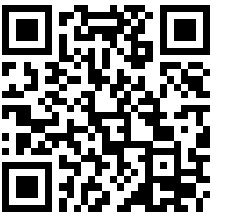

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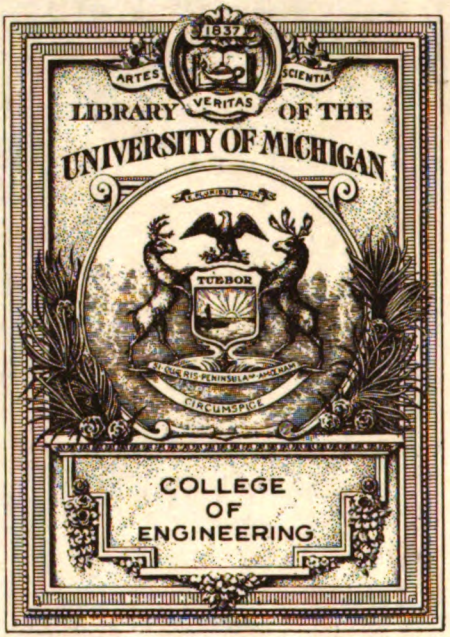

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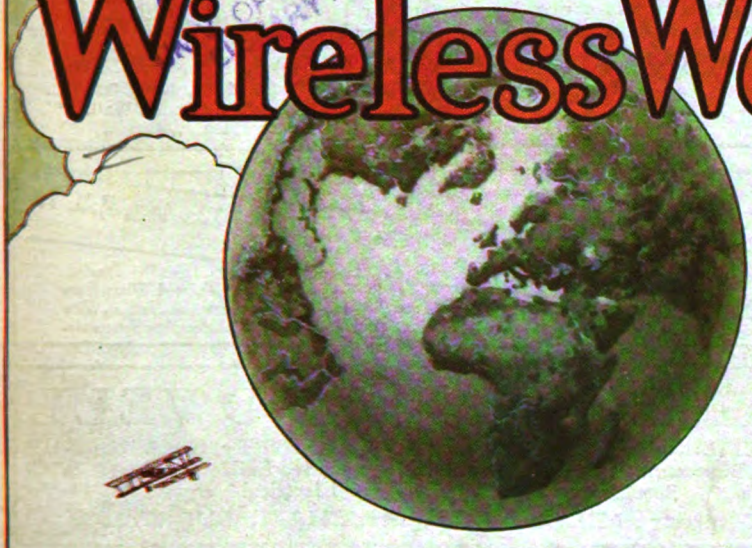

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SUBSCRIPTION RATES.—United Kingdom and British Empire (outside North America), 9s. per annum, post free; United States, Canada, and Newfoundland, $2.25 per annum, post free; and Europe, frs. 11 per annum, post free.

Single copies, 7d. each, or post free 10d.

Articles submitted for acceptance by the Editor (which will be paid for on publication) should be addressed to Marconi House, Strand, London, W.C.

Telegraphic Address: "Expanse, Estrand, London." Tel. No.: City 8710 (10 lines).

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The
WIRELESS
WORLD

Volume VI. No. 61. APRIL, 1918.

Summer Days in Constantinople

By P. W. HARRIS

WE had come down to Constantinople on one of the numerous ferry steamers which play the part of a tram service and unite the suburban villages which nestle on the banks of the Bosphorus. With a jolt and a creak the little craft, which seemed strangely reminiscent of a Thames steamboat, drew up against one of the landing stages by the Galata Bridge, and in the twinkling of an eye the packed decks were clear of their human freight. Here, in the Golden Horn, which quivered and glittered in the burning sunlight of a summer day, were crowded craft of every imaginable description—lumbering barges which a few hours before had laboriously toiled their way across the Sea of Marmora, bringing melons and other fruit to the Constantinople markets; slender caiques darting here and there under the skilful handling of Turkish boatmen, every bit as adept as the famous Venetian watermen; laden Greek merchantmen ready to sail for Mediterranean ports; British tramp steamers calling at Constantinople on their way from the Black Sea, and a dozen or more ferry steamers whistling and snorting in their endeavours to find a vacant landing place at one of the many quays. Unaccustomed as we were to the scuffle and crowding of this busy city, it was some time before we

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A TYPICAL STREET SCENE IN CONSTANTINOPLE.

emerged from the crowd and reached the bridge by way of a creaking staircase. Once on the bridge, however, we felt more free, and were able to look around.

The three of us from the yacht on which I was serving as telegraphist had come on this, the first of a series of visits, to see the sights of the native quarter, and pay a call at the world-famed mosque, Saint Sophia. There is perhaps no place in the world which offers more interest to the visitor, or where life is more kaleidoscopic and varied. Crossing from the centre of the Galata Bridge, which spans the Golden Horn joining Galata and Pera (the European quarters), and Stamboul, which may be termed Constantinople proper, we found ourselves mingling with the stream of foot passengers seemingly of every race and class. Every two yards whining beggars crouched against the ironwork of the bridge thrusting out their filthy palms, or, worse still, exhibiting their maimed and contorted limbs in the everlasting appeal for alms. Porters, known locally as "Hamals," stoically carried loads, the like of which none of us had ever previously seen carried on a human back. We had not gone many yards before we passed one staggering hamal bearing on his back a moderate-sized piano!

Greeks with European headgear, Turks and Armenians with the well-known red fez, swarthy Persians wearing headdresses of astrachan, elderly sheiks with large turbans wound round their fez, passed to and fro incessantly. Women, some heavily veiled with the famous yashmak, and others, more modern perhaps and less fettered by tradition, with the thinnest of veiling through which their faces could be plainly seen, were conspicuous in the crowd, and wandered singly or in

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groups chattering in high-pitched voices. They could recognise their friends, it seemed, through their veiling, although to us they appeared all alike.

Drainage systems are unknown in this part of the world, and only a few years ago the city was overrun with pariah dogs, which acted as four-footed scavengers. Some little while before our visit these dogs had become such a nuisance, and had grown so fierce from years of toleration, that it was decided to remove them. The obvious thing to do was to destroy these beasts by one of the many methods available, such as by poisoning or lethal chambers. But methods such as these offended against the Mohammedan religion, for, according to the rules, it was wrong to kill them. "Where there is a will there is a way," however, and it was decided by the ruling officials that the dogs should be collected and placed upon one of the islands in the sea of Marmora. With a great deal of trouble, and much biting, this plan was carried out—thousands upon thousands of wretched, half-starved dogs being cast, without a scrap of food or water, upon an uninhabited island a few miles away. There they went mad, one by one, attacked each other, and died in the greatest misery.

Returning to the object of our visit, in due course we came to the entrance of the famous mosque, which is not difficult to find, as, owing to its position, it stands out as a landmark. After a short conference we decided to engage a guide, and

BEIKOS: A VILLAGE ON THE UPPER REACHES OF THE BOSPHORUS.

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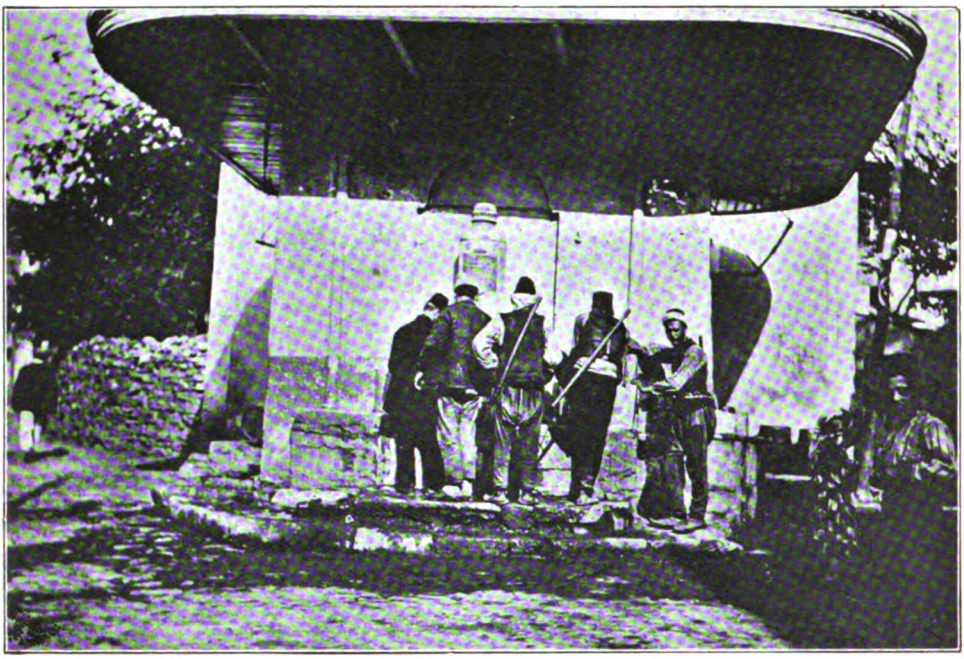

PUBLIC FOUNTAINS ARE NUMEROUS AND FREQUENTLY ORNAMENTED WITH CARVED AND GILT LETTERING.

soon we were fortunate enough in coming across a professional dragoman, by all appearances a Turk of Turks, and dressed accordingly. Later events showed that our choice was a wise and fortunate one. It so happened that for months afterwards this guide was referred to among the ship's company as "Marconi's Special "Friend," for on hearing that I came from London he confided to me that he was really an Italian, and at one time made a great deal of money in hawking carpets at Finsbury Park!

Adequately to describe the beauties of Saint Sophia in a large volume would be an impossibility. To give any indication of the interest of this great edifice in a short article can scarcely be attempted. It should be noted, however, that although used as a mosque for the last 500 years it was originally built as a Christian church by the Emperor Justinian. Prior to the building of the present structure, the Christian Church had existed on the spot from the year 326 A.D., but the original church was burnt to the ground, as was also the second erected on its site, and it was not until 532 A.D. that the present pretentious building was started. The Emperor Justinian decided that Saint Sophia should be the finest and most gorgeous structure in Christendom, and to this end engaged the best talent available at the time. Originally gold, silver and jewels were lavishly used to adorn the church, and the interior was largely covered with gorgeous mosaics. Many of these latter remain on view to the present day, although the greater portion have been destroyed by the numerous earthquakes which have devastated the region. Even now, and

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in spite of the fact that much of the beautiful decoration has been whitewashed over by the Turks in converting the church into a Mohammedan mosque, much of the gorgeous effect endures, and of the 107 columns scarcely two are made of the same kind of marble. It is said that, Justinian, on driving to the church for the opening ceremonies, raised his hands to heaven and cried, "Blessed be God Who "has chosen me to execute such a masterpiece. I have surpassed thee, oh "Solomon!"

Standing in the nave and looking around it seems incredible that this great Byzantine church was built in five years, but such in truth is the case. Had a longer period been given to the building it would probably have been much stronger, and one of the results of the "rush" was that, twenty years after the opening, a slight earthquake destroyed a part of the dome, the altar, and many of the most precious objects. There is a Mohammedan legend that this earthquake coincided with the birth of the Prophet.

There are many details in Saint Sophia which are likely to be missed by the visitor unless he is under conduct of a guide. Among these should be mentioned the imprint of a bloodstained hand, high on one of the walls, and said to be the mark of Muhammed the Second, the Turkish invader who captured Constantinople, drove out the Christians, and converted the Christian church into a mosque. Then,

A TURKISH CEMETERY. THE SIZE OF THE TURBAN INDICATES THE SOCIAL RANK OF THE DECEASED. THE SECOND STONE FROM THE LEFT MARKS THE GRAVE OF A WOMAN.

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TURKISH RESIDENCES ON THE ASIATIC SHORE OF THE BOSPHORUS. THEY ARE MOSTLY BUILT OF WOOD.

again, there is the famous "cold window" on the western side, through which, day and night, summer and winter, there blows a cold wind irrespective of the temperature outside. We had good proof of this, for when we went to inspect the window the draught was almost icy, although outside we knew it to be a burning hot day. Another interesting object is known as the "weeping pillar"—this pillar contains a hole in which the finger can be inserted, and which is always dripping with water. Superstitious people ascribe to this many curious properties. We were not told why this moisture is always present, but it is probable that the base of the column rests upon ground near a spring.

Suspended from the roof are thousands of lamps, consisting of nothing more than small glass bowls which can be filled with oil and a simple floating wick. These lamps are lighted but once a year, on the feast of the Ramazan. On this night Saint Sophia is packed with the faithful, and there are frequently wild scenes of fanaticism should any number of foreigners be in the locality. Ramazan does not always occur at the same time of the year, as the Mohammedan differs in length from the Christian year. It so happened that at the time of my visit Ramazan fell in the hottest part of the year, not long after we arrived. The religious rites on this great feast-night were a sight to be viewed, if possible, so a party of English residents and visitors, including ourselves, had arranged to witness the ceremony

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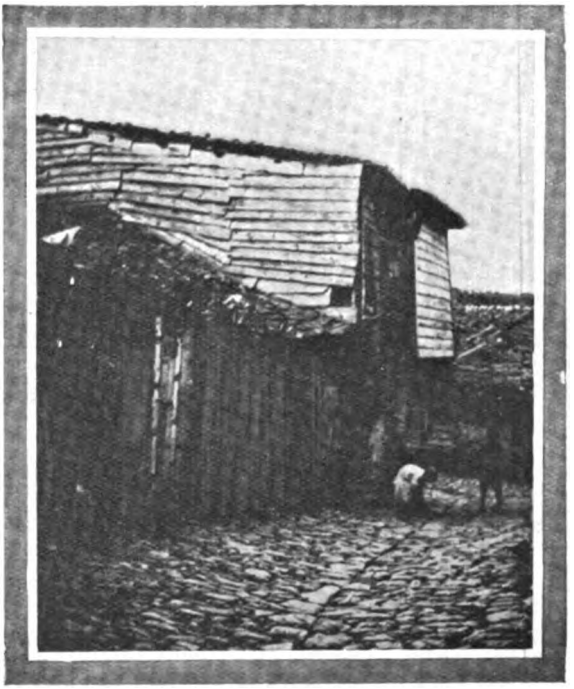
from one of the galleries. At the last moment, however, and much to our disappointment, word came from the Embassy that it would be inadvisable for us to go.

By the time we returned up the Bosphorus to our anchorage at Beikos evening was falling. I know of no more beautiful spot in the whole of Europe than this waterway connecting the Black Sea and the Marmora. On both sides hills rise up from the water's edge, and here and there are small villages, with numerous cafés where the Turks idle away their time. Palaces, large and small, and in various states of repair, line the Bosphorus on both sides, many of them, if not the majority, being of wood, but others of plaster, brick, stone, and even marble.

A few miles up the Bosphorus, and nearer to the Black Sea, are situated the summer residences of the various embassies. In this district I remarked quite early in our visit a palatial building, bigger than any of the others, and surrounded by a high wall, quite obviously kept in perfect repair, and as clean and fresh as a new pin. It was situated not far from the German Embassy. I went to some pains to discover who was the proud possessor, learning, after a little trouble, that it belonged to Krupp's agent.



TYPICAL HOUSES OF THE POOREST QUARTER.

Whilst my summer days were spent either in Stamboul and the European parts of Constantinople, or in the numerous picturesque villages in the vicinity, my evenings and sometimes whole nights were spent "listening in" and experimenting with the wireless apparatus. The general conditions for wireless experimentation were as near ideal as it is possible to imagine, for "freak" nights were in the minority, and there was practically no interruption from nearby stations.

Every night after sundown I could rely on hearing loud signals from Pola, at the head of the Adriatic, Sebenico, Port Said (some 650 miles to the south), Fort de l'Eau, and frequently Saintes Maries de la Mer (Marseilles). On long wavelengths the near-by station at Constantinople could be heard working frequently to Adrianople—it was at the time of the siege of the latter city—but generally "pumping out" messages by the hour with 3 kilowatts to the Turkish "Fleet" lying practically in sight. On one or two rare occasions, after setting the receivers to the maximum sensitiveness, I succeeded in hearing signals from Eiffel Tower, but they faded away after a few minutes and were not heard again.

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PERSONALITIES IN THE WIRELESS WORLD

MR. J. ORCHISTON, M.I.E.E.

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THE wire telegraph service in New Zealand is justly a source of pride to the inhabitants of that distant and progressive Dominion, and from articles which have appeared in this magazine our readers will know that the radiotelegraphic service is equally well managed.

The subject of our biography this month, Mr. J. Orchiston, M.I.E.E., is the Chief Telegraph Engineer of the General Post Office at Wellington, New Zealand, all radiotelegraphic matters in that country being handled by his department.

Mr. Orchiston, who was born in Aberdeen, Scotland, in the year 1857, left the "Old Country" with his parents at the early age of five. When seventeen years old he joined the telegraph department as a cadet, and shortly afterwards was placed in charge of the Hawera Office. After performing the duties pertaining to officer-in-charge and postmaster for three and a half years, he was transferred to the technical branch of the service. At the age of twenty-one he was Acting Sub-Inspector in charge of all construction work in the Wellington District, and two years later was promoted to the rank of Sub-Inspector and placed in charge of the Auckland Telegraph District. In 1894 his designation was altered to that of Inspector, and he was transferred to the Otago District, and finally promoted to the position of Chief Engineer, at Wellington, in January, 1911.

In view of the exceptionally favourable atmospheric conditions which exist in that quarter of the globe, we may expect many interesting post-war developments under such able leadership. Who knows but what direct communication with the Motherland may be established before many years have passed?

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The Evolution of the Thermionic Valve

By R. L. SMITH-ROSE, B.Sc., A.R.C.S., D.I.C., Student, I.E.E.

Read before the Students' Section of the Institution of Electrical Engineers on January 22nd, 1918.

Elementary Thermionics.

I.

The term "Thermionic" currents was first applied by Professor O. W. Richardson, in 1902, to the currents obtained by the emission of electricity from solid bodies raised to a temperature of incandescence. Since then the term has come into very general use in dealing with this subject, and the valves used for radio-telegraphy and other purposes, which depend upon this phenomenon for their action, are most suitably designated by the title "Thermionic," or, more briefly, "Ionic Valves."

Although it is nearly two hundred years since it was first observed that the air in the neighbourhood of red-hot metals is a conductor of electricity, the chief advance in our knowledge of this phenomenon has taken place during the last twenty or thirty years. Among the earlier investigators, Guthrie, in 1873, was the first to call attention to the distinction between positive and negative electrification.* He showed that a red-hot iron ball in air could retain a charge of negative but not of positive electricity, whereas when the ball was raised to a white heat it could not retain either a positive or negative charge.

The first systematic investigations were carried out by Elster and Geitel† during the years 1882–9. They studied in great detail the charge acquired by an insulated metal plate mounted close to a metallic filament within a glass bulb, under different conditions of filament temperature and gas pressure.

When the gas is air or oxygen at atmospheric pressure, the metal plate receives a positive charge which increases as the temperature of the filament is increased, until this is at a yellow heat. As the temperature is raised above this point the charge diminishes until, with the filament at a bright white heat, the charge received by the plate is very small. When the pressure of the gas inside the vessel is reduced, the charge received by the plate diminishes, and as the exhaustion proceeds a point is reached at which the charge changes sign, and for high filament temperatures and low gas pressures the charge on the plate reaches a large negative value. Both the sign and magnitude of the electrification are influenced by the nature of the substance comprising the filament and also by the nature of the gas; for example, Elster and

* *Phil. Mag.* iv. 46, p. 257 (1873). † *Wied. Ann.* 1882–1889.

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Geitel showed that in hydrogen the plate acquired a negative charge, even at atmospheric pressure.

At the Philadelphia Exhibition in 1884 Edison exhibited a discovery made by him during his investigations upon incandescent electric lamps.* The phenomenon, which has since become generally known as the "Edison effect," is briefly as follows:

A small insulated metal plate is sealed into an incandescent lamp, between the legs of the horse-shoe-shaped filament. When the filament is made incandescent by direct current, and a galvanometer is connected between the insulated plate and the negative end of the filament, practically no current will be observed flowing through the galvanometer; whereas if the galvanometer is connected between the plate and the positive end of the filament a current will be observed flowing through the galvanometer, in direction from the filament to the plate, the current amounting to two or three milli-ampères, under suitable conditions. Neither Edison nor Sir William Preece, who subsequently carried out some experiments on this effect, gave any explanation of the phenomenon, nor was any practical application made of it.

Professor J. A. Fleming,† in 1890, showed that when the negative leg of the carbon loop was surrounded by a cylinder of either a metal or an insulating substance, the Edison effect almost entirely disappeared, and other experiments of a similar nature showed that the effect was due to passage of negative electricity from the incandescent filament to the cold electrode, an occurrence which Elster and Geitel, by a somewhat different method, had previously demonstrated in very high vacua.

Fleming also showed that the Edison effect is obtained, although to a very much smaller degree, when using platinum, instead of carbon, for the incandescent filament.

At this time the existence of electrons was unknown, and the flow of current between the incandescent filament and the metal plate was attributed to the passage of negatively charged carbon atoms. This view was also apparently supported by the fact that both carbon and platinum give off very fine dust, if they do not actually volatilise at high temperatures, as shown by the familiar deposit of carbon or metal on the glass walls of an evacuated vessel in which a filament has been glowing for a long period.

In 1899, however, Sir J. J. Thomson announced his epoch-making discoveries concerning masses much smaller than atoms, carrying a charge of negative electricity, which were first called "corpuscles," but which are now generally known as "electrons," and are still regarded as the ultimate units or elements of negative electricity. These electrons were shown to be the carriers of the negative electricity in the cathode rays present in the high tension discharge through a vacuum tube, and from measurements made in Sir J. J. Thomson's classical experiments it was shown that, while each electron carried the same charge as that carried by a hydrogen atom, its mass is equal to approximately only $\frac{1}{1800}$ of the mass of a hydrogen atom.‡

Similar measurements showed that in the case of a carbon filament glowing in

* Dyer and Martin, *Edison, His Life and Inventions*, Vol. II. † *Proc. Royal Institution*, 1890.
‡ J. J. Thomson *Conduction of Electricity through Gases*, Chapters V. and VI.

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hydrogen at a very low pressure the negative electricity is given off by the filament in the form of free electrons.*

It was subsequently proved by Wehnelt that the electric current emanating from a lime-covered platinum cathode (the well-known Wehnelt cathode) is carried in the same manner by these negatively-charged corpuscles,† and that the current from such a cathode is much greater than that obtained from the platinum alone.

Hence it may be said that when a metal or carbon filament is rendered incandescent in a highly-exhausted vessel there is a continual evaporation or emanation of negative electricity from it in the form of electrons, the rate of such emanation being dependent, in the first place, on the nature and temperature of the glowing filament and on the nature and pressure of the surrounding gas.

This emission of electrons is readily explained by the electron theory which assumes that these negatively-charged corpuscles are disseminated through metals and carbon at all temperatures; they are in constant vibratory motion similar to that of the molecules of a gas, and are free to move in any direction under the influence of an electric force. These free electrons are normally retained within the metal by the electric force at the surface, which acts in a similar manner to the force at the surface of a liquid tending to prevent the molecules of the liquid escaping into the region above it. If the velocity of any electron is sufficiently high its kinetic energy may be great enough to carry it through the surface layer, and so enable it to escape from the metal into the surrounding space. Since the average velocity of the vibratory motion increases rapidly with the temperature, then, as the temperature increases, more and more of the electrons will be able to get through the surface layer and escape from the metal, the whole process being exactly analogous to the evaporation of a liquid with increasing temperature.

Applying the electron theory in this manner, Professor O. W. Richardson found that the rate of emission of electricity from incandescent bodies could be expressed by an equation of the form:

$$N = a\sqrt{T}\,e^{\frac{-b}{T}}$$

where N is the number of electrons emitted per square centimetre of the hot body per second. T is the absolute temperature of the body, and a and b are constants. Richardson's measurements of the current obtained from a hot wire at different temperatures agree well with a formula of this form, and from his observations on different substances he gives the following values for the constants a and b ‡:—

For carbon: $a = 10^{34}$, $b = 9{\cdot}8 \times 10^4$
,, platinum: $a = 7{\cdot}5 \times 10^{25}$, $b = 4{\cdot}93 \times 10^4$

These figures show that the emission from carbon is much greater than that from platinum. The rate of emission from tungsten at different temperatures, as calculated from an equation of the above form by Dr. Irving Langmuir, is shown by the curve in Fig. 1.

* J. J. Thomson, *Phil. Mag.* xlviii., p. 547 (1899). † Wehnelt, *Phil. Mag.* x., p. 80 (1905).
‡ J. J. Thomson, *Conduction of Electricity through Gases*, 2nd Edition, p. 201.

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According to Richardson's theory an incandescent metal at any temperature emits electrons at a definite rate, which is independent of the electric field surrounding the hot body. If there is no electric field in the space surrounding the incandescent body, the electrons emitted return to the body and are reabsorbed. If, however, a positively charged body is brought near the heated solid, the electrons emitted will be drawn towards and absorbed by this body, their passage across the intervening space constituting an electric current flowing from the hot filament as cathode to the positively charged body as anode. The currents obtained in this manner were termed by Richardson "Thermionic Currents," a term which has since come into very general use.

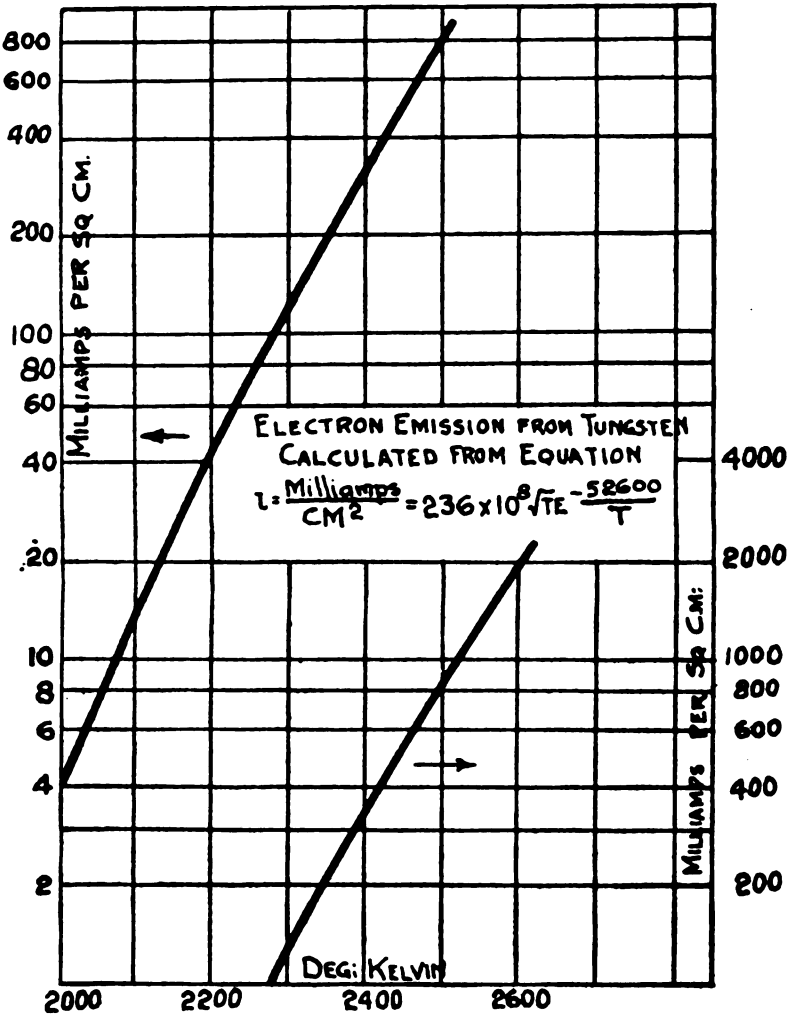

FIG. I.

If a negatively-charged body is brought near the hot filament, the electrons will be repelled from it and will ultimately return to the filament in a similar manner to the case in which there is no field external to the filament.

Viewed in this manner, the electron emission is independent of the flow of a thermionic current, the latter only taking place when a positively-charged electrode is brought near the glowing filament. As the potential of this electrode is increased, an increasing proportion of the electrons will be attracted towards and absorbed by it

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until finally a point is reached at which all the electrons emitted by the hot cathode are absorbed by the cold anode, and any further increase in potential of the latter will produce no increase in the current flowing to it. At this stage the thermionic current is said to be "saturated," and the magnitude of this current will be equal to the total charge carried by all the electrons emitted by the hot cathode per second.

The theory as thus put forward would apparently give a satisfactory explanation, both qualitative and quantitative, of elementary thermionic phenomena ; but there are many experimental results which are not so readily explained and which have brought to light one important feature which must be borne in mind when comparing the theoretical with the experimental results. The above theory takes no account of the action of the gaseous atmosphere surrounding the hot cathode, and it has now been well established that, unless very special precautions are taken to exclude it, the residual gas present in our so-called "high vacua" exerts a very marked influence upon the thermionic emission from any heated body enclosed in an exhausted vessel.

For instance, it has already been stated that when a metal wire is heated to a dull red heat the first effect consists in the production of positive ions round the wire, which increase in number as the temperature of the wire is raised, up to a certain value. Above this value of the temperature negative ions make their appearance, and these increase at a greater rate than the positive ions, until finally the sign of the resultant charge given off by the metal is negative. The presence of oxygen at pressures approaching one atmosphere favours the emission of the positive charge, while a diminished gas pressure or the presence of hydrogen has a marked effect in increasing the number of negative ions.

This action of the residual gas in the space surrounding the heated body and a similar action due to the presence of slight impurities in the heated body itself have been subjected to much investigation since Richardson first put forward his theory, and the results have emphasised the importance of taking these considerations into account. H. A. Wilson has shown that the electron emission from a hot platinum wire can be reduced to 1/250,000 of its former value by a preliminary boiling of the platinum wire in nitric acid to free it from the hydrogen which it so readily occludes on its surface.* The admission of a little hydrogen brought the current back to its former value. On one occasion during these experiments when a little phosphorus accidentally got on the wire the emission was enormously increased. In all cases, however, he found the variation of the emission with temperature could be expressed by the relation given above.

Some experiments carried out by Pring & Parker in 1912 showed also that the thermionic currents obtained from incandescent carbon in a vacuum decreased to extremely small values as the carbon is very carefully purified and the vacuum improved.†

Richardson also has shown that the positive emission from a heated wire is of a transitory nature. If the metal is heated at a constant temperature, the emission

* H. A. Wilson, *Phil. Trans.* 202, p. 243 (1903). † Pring & Parker, *Phil. Mag.* xxiii., p. 192 (1912).

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of positive ions falls off rapidly with time, the rate of decay increasing rapidly as the temperature is increased.

The results obtained by these and other investigators led to considerable doubt being thrown on Richardson's theory, and it was suggested the thermionic currents obtained in the majority of, if not in all, cases were due to chemical action arising from the impurities in the heated wire or the gas surrounding it, and that if a perfectly pure metal were heated in a perfect vacuum there would be no electron emission from it.

A very common example illustrating how small is the electron emission from an incandescent metal in a high vacuum is afforded in the ordinary tungsten filament incandescent lamp. The vacuum inside a tungsten lamp is very high, probably of the order of one-millionth of a millimetre of mercury after the lamp has been burning for some time, while the high efficiency of the lamp is due to the refractory nature of the metal, tungsten, enabling it to be run at such a high temperature without fear of its melting. It is evident that in the ordinary lamp the current flowing from one part of the filament to the other must be very small, whereas, according to Richardson's equation and experimental results, the thermionic emission from tungsten at temperatures near its melting point might amount to several ampères per square centimetre of its surface.

Dr. Irving Langmuir, however, has recently studied in great detail the thermionic currents from tungsten filaments in extremely high vacua, the pressures used being of the order of one-millionth of a millimetre of mercury or less ; and he has shown that the smallness of the currents previously obtained was not due to the failure of the filament to emit electrons, but due to the potentials applied to the anode being insufficient to enable the space surrounding the filament to carry the currents which could otherwise be obtained.* As a direct result of his investigations he concludes " that the electron emission from heated metals is a true property of the metals themselves, and is not, as has so often been thought, a secondary effect, due to the presence of gas."

In a typical experiment of Dr. Langmuir's two single-loop tungsten filaments were mounted in a bulb, which was then exhausted to the highest possible degree, utilising special methods of exhaust and special methods of treating the electrodes to free them from all occluded gas. One of the filaments was heated by an electric current and was used as the cathode, while the other filament served as the anode. A constant positive potential was applied to the anode in series with a galvanometer, and by varying the cathode heating current the relation between the thermionic current measured by the galvanometer and the temperature of the cathode was obtained and plotted in the form of a curve.

This curve representing the thermionic current as a function of the temperature consisted essentially of two parts ; during the first part the current increased according to Richardson's equation, and was independent of the voltage and the shape and size of the anode, whilst during the second part of the curve the current was influenced by both of these factors. If the dimensions of the anode and its potential

* I. Langmuir, *Proc. Inst. Radio Engineers*, April, 1915 ; *General Electric Review*, May, 1915 ; *Electrician*, lxxv., 240 (1915).

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are maintained constant the current finally reaches a saturation value, and any further increase in temperature of the cathode produces practically no increase in the thermionic current. The greater the potential at which the anode is maintained, the greater will be the value of the saturation current and the higher will be the temperature to which the cathode must be raised before this saturation value is reached.

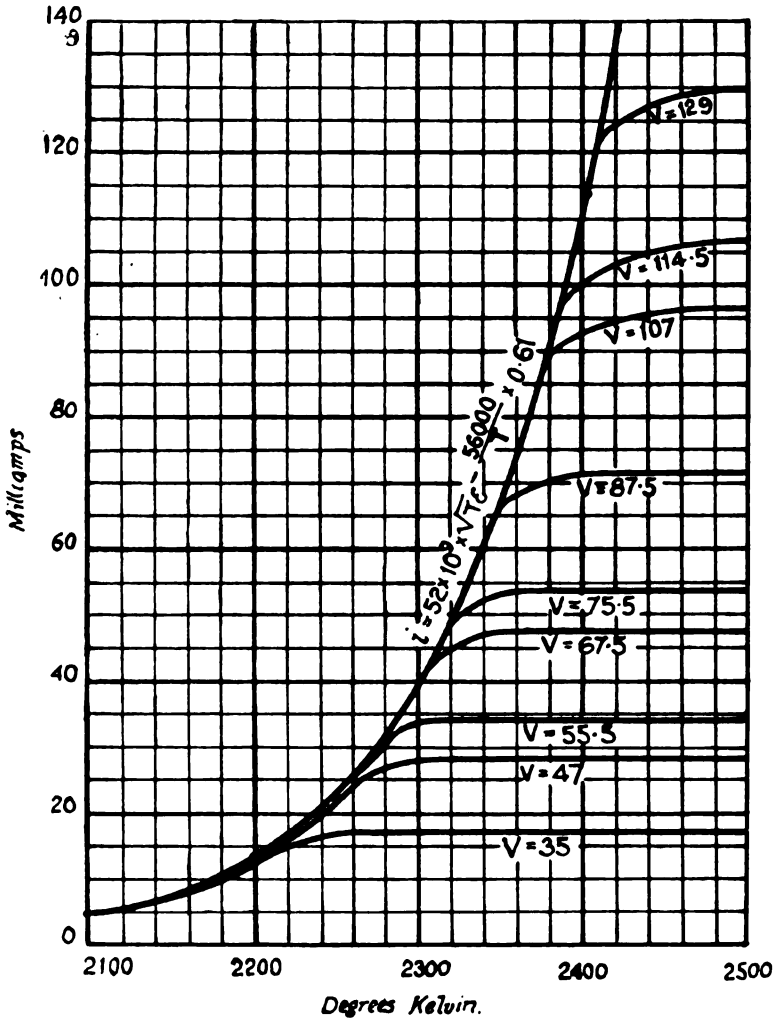

FIG. 2.

Fig. 2 shows a typical set of "current-temperature" curves obtained in the manner described above for different voltages applied to the anode. It will be observed that the early parts of all the curves coincide with the curve plotted from Richardson's equation.

This limitation of the thermionic current by the potential applied to the anode was found to be due to the electrons carrying the current constituting an electric "space charge" between the electrodes, which repelled the electrons escaping from the hot filament causing them to return to it. Langmuir has calculated the effect of this space charge, and finds that, in any bulb, the maximum thermionic current that can be carried by the space between cathode and anode is proportional to the potential difference between the electrodes raised to the power 3/2; and his experimental results are in complete accordance with this law, in the cases where

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the vacuum is so high that there is no appreciable positive ionisation within the bulb.*

The presence of a very minute trace of gas within the bulb, however, may lead to the formation of positive ions, sufficient to neutralise to a large extent the electronic space charge, and so greatly increase the current carrying capacity of the space. For instance, the presence of mercury vapour at a pressure of 10^{-5} mm. has been found, under suitable conditions, to completely neutralise the effect of the space charge, so that a current of 0·1 ampère was obtained with 25 volts on the anode, whereas without the mercury vapour over 200 volts were necessary to draw this current through the space.

Apart from this enormous effect on the current-carrying capacity of the space, the presence of a gas or vapour within the bulb exerts a considerable influence upon the thermionic emission from the cathode. But Langmuir found, contrary to the previously generally accepted opinion, that when the cathode is of pure tungsten the effect of any gas present is to decrease rather than increase the electronic emission. For example, it is found that the presence of oxygen or a gas containing oxygen, such as water vapour, at a pressure of 10^{-6} mm. will cut down the electronic emission to a small fraction of the value obtained in high vacuum.

This reduction of the emission by the presence of a gas is probably due to some chemical action, for it has been found that the inert gases of the argon group produce no such effect, and this fact has been employed in one type of rectifying valve, to obtain neutralisation of the space charge effect, without reducing the electron emission from the tungsten cathode.†

Having thus briefly reviewed the progress of our knowledge of the subject of thermionics, we will now proceed to consider the application of this knowledge in the various types of thermionic valves, used for the rectification, amplification and generation of alternating currents.

(To be continued.)

Share Market Report

LONDON, *March 12th*, 1918.

BUSINESS has been fairly active during the past month in the shares of the Marconi Group. The shares of the American Company are receiving marked support in view of the imminence of the publication of the figures. All other classes of shares have been well supported and show a marked upward tendency as we go to press. Marconi Ordinary, £3 3s. 9d.; Marconi Preference, £2 13s. 9d.; Marconi International Marine, £2 11s. 3d.; Canadian Marconi, 10s. 9d.; American Marconi, £1 5s.; Spanish and General, 9s.

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* I. Langmuir, *Physical Review*, ii., p. 450 (1913).
† G. S. Meikle, *Gas-Filled Rectifier, General Electric Review*, April, 1916; *Electrical Review*, lxxviii., p. 472 (1916).

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Digest of Wireless Literature

Wireless Equipment on Submarines.

In a recent issue of the *New York Times*, an article was printed giving many particulars of the wireless equipment on German submarines. To receive or transmit wireless messages, says the writer, part of the apparatus must be raised above the earth or the water's surface. Much of the time the U-boat is below the water, and even when afloat, her masts rise but a few feet. Space, too, is so limited that it is difficult to find room for the rather bulky apparatus, and the extreme violence of the boat's movements in even a moderate sea adds greatly to the troubles of the wireless man.

The submarine wireless is so vital to these boats, that the problem has been attacked with unusual energy. Improvement in wireless equipment and methods has been amazing. Even at the beginning of the war the methods were comparatively crude. The most remarkable advance has come only within the past few months.

It is difficult to guard wireless secrets successfully against big fleets of warships and patrol boats in the waters infested with U-boats. German submarines, with their wireless equipment intact, are captured from time to time, thus enabling wireless experts to discover their newest secrets.

The great problem in fitting a submarine with wireless is to raise the antennæ as high as possible. At first special masts were built, which were set up amidships when the U-boat came to the surface, and the aerials were strung from the top of it to the furthermost ends of the deck. The sending radius was naturally limited. At the commencement of hostilities this was the only practicable method. The next step was to raise two masts, one at either end of the boat, and sling the aerials between them.

Telescopic masts then appeared, so that when the submarine came to the surface these masts were quickly pulled out to their extreme length, and set in place. The range both for sending and receiving messages was thus much increased. One of the great advantages of the telescopic device was the speed with which it could be adjusted. When the U-boat could show itself for only a few minutes, it was possible to put the wireless apparatus in place in a short time. At the signal to take down the wireless, preparatory to submerging, the masts could be taken down and folded up in a few seconds. Should a submarine go under with its wireless masts still in position, it ran the risk of having them carried away and lost.

Several German boats, says the article, have been captured carrying an ingenious

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device for winding up the aerial automatically, in order to save a few priceless seconds. The wire was coiled up instantly by the mere touching of a spring. Such apparatus, or adaptations of it, are still in use on some of the German submarines.

According to the article, for the accuracy of which of course we cannot vouch, the newest German device for extending the range of wireless signalling is a highly ingenious use of balloons. The success of the U-boats is believed to be largely due to this. Antennæ are raised to a height of at least 2,000 feet above the sea by means of the balloons, two of which are used connected by a stiff rod. When an enemy is sighted they are pulled down quickly by means of a windlass operated by electricity. The balloons are painted partly white and partly blue, so that they are scarcely distinguishable from the sky.

It is practically impossible, therefore, to bring them down with anti-aircraft guns. With the antennæ raised to the height of half a mile, it is possible to receive wireless communications from almost any part of the world.

ELECTRICAL CONDUCTION IN METAL AT LOW TEMPERATURE.

The experiments of H. K. Onnes, on the resistivity of metals and liquid helium temperatures, have shown that certain metals possess an increased conductivity when the temperature, current density, and magnetic field are less than certain critical values. It is pointed out by F. B. Silsbee, in a recent publication of the Bureau of Standards, that a definite relationship is to be expected between the values of critical current and critical field, and that this relation is in agreement with the experimental data available.

The present state of our experimental knowledge of this subject is somewhat as follows: Certain metals—mercury, tin and lead—at the very low temperatures obtainable in a bath of liquid helium, show a very greatly increased electrical conductivity to which Onnes has given the name "superconductivity." The actual resistivity of the metal in this state is too small to measure, but has been shown to be less than 2.10–11 times the resistivity at 0° C. As the temperature of any of these metals is lowered from room temperature the resistance decreases uniformly with the normal co-efficient of about 0.4 per cent. per degree, until the temperature is very low, when the rate of decrease becomes for a time less rapid. At a certain critical temperature, however (4° 2 K for mercury, 3° 8 K for tin, and 6° K for lead), there is a sudden break in the curve connecting resistance and temperature, and within a temperature range of a few hundredths of a degree the resistance drops from about 10–8 times its value at 0° C. to less than 10–10 times the same value. Other metals, such as gold, silver, platinum, iron, etc., do not show this phenomenon, and their resistivity tends to approach a constant value as the temperature is lowered to the lowest value (1° 6 K), at which such measurements have been made.

It is further found that when a superconductor is placed in a weak magnetic field it remains superconducting, but that, as the field is increased, the normal resistance appears suddenly at a certain critical value of the magnetic field, and, for still higher values of field, increases slowly with the field.

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THE DETECTION OF UNDAMPED OSCILLATIONS.

It is a well-known fact that undamped oscillations cannot be detected by the ordinary radio-frequency rectifier, because of the fact of the advancing wave train. Hence some means must be provided at the receiving apparatus whereby the incoming signals can be converted into an audio-frequency current suitable for operation at the head telephones. A recent United States patent, granted to Elmer E. Bucher, shows a novel method for converting radio-frequency currents into currents of audio-frequency. The mechanical receivers heretofore adopted for such a detection have been either the tikker or the slipping contact detector, both of which possess the disadvantage that they were somewhat troublesome in adjustment, and would give an impure or imperfect note in the head telephones. Besides these methods there are, of course, those utilising the vacuum valve already explained in the pages of this magazine. The novelty of the system disclosed by the inventor lies in the use of a rotating condenser of variable capacity, which is placed in various positions in the receiving circuit to vary the amplitude of the incoming oscillations. The rotating condenser resembles in construction the ordinary air condenser composed of two sets of plates interleaved with one another. In the case of this invention, the moveable plates are attached to the shaft of an electric motor. One method of connecting the rotating condenser to the receiving circuit consists in substituting it for the usual variable condenser shunted across the secondary inductance. Across this the crystal detector and telephones, together with a small condenser, are shunted in the usual fashion. If the value of the secondary inductance is properly adjusted, so that at a certain position of the revolving condenser the circuit is in resonance with the incoming oscillations, current will flow periodically through the crystal rectifier, charging the condenser across the telephones, this condenser discharging through the telephones in the usual fashion. If the rotating condenser is of such construction, or revolves at such speed that the secondary circuit is thrown into resonance with the aerial circuit, say 500 to 750 times per second, a very clear tone will be obtained in the telephones. If the condenser is stopped at the required value of capacity the circuit will respond equally well to damped waves. Other arrangements place the rotating condenser directly in series with the aerial, and in a separate circuit coupled to the aerial.

THE ARLINGTON WIRELESS STATION.

A recent issue of the *Electrical Experimenter* gives an article from the pen of a wireless amateur who had an opportunity, not long ago, of visiting this powerful station. Speaking of the lattice towers, which are well known to our readers from the photographs which have appeared from time to time, the writer says that illustrations cannot possibly give an idea of the immense size of these structures. The receiving room he describes as built like an ice box, with walls 2 feet thick. Inside the room not the slightest sound is heard from the adjacent transmitting plant. Two men are always on duty, one in the transmitting room, and one in the receiving room. On the receiving operator hearing a call, he signals to the transmitting room to start up the set, he himself transmitting by means of a relay key.

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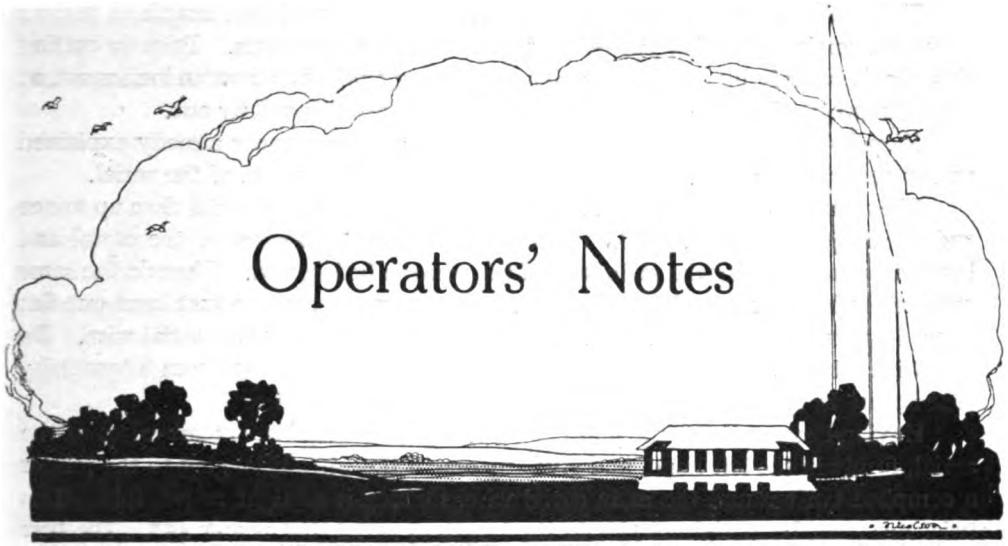

Repairing an Aerial

By HAROLD WARD

I WONDER how many operators splice their own aerials when necessity arises? Very few, if any. The very word "splice" seems to raise up a terrifying picture of ropes and spikes in a seemingly hopeless tangle, with dozens of seemingly useless ends. The usual procedure is to go to the bo'sun, who tells off an A.B. to do it for you. On some boats it would be considered *infra dig.*, I know, for anyone in a double-breasted brass-buttoned coat to do such work, but at the same time much more satisfaction is derived from a job done personally.

Now although to splice correctly a seven-strand wire requires considerable experience, a very satisfactory substitute joint—this is the age of substitutes—can be readily made. The method employed is simplicity itself, although the explanation is necessarily somewhat involved, and after a little practice an operator should be able to turn out a firm joint in fifteen minutes or less.

Proceed, then, as follows. Lay the broken aerial along the deck, with ends touching, and measure the length of rotten or damaged wire which it is advisable to remove. If the break has occurred above the funnel this will be about twenty or thirty feet. Cut out the damaged wire with pliers, and about nine or ten inches higher up bind tightly with string. This is to prevent the ends from flying out.

Untwist the seven component wires and splay them out, wide apart. Should each component wire be of seven smaller strands, these ends should be temporarily bound with string. An ordinary seven-strand wire is usually formed of six strands wound round a central one known as the "core." This core should be cut off at the point where the other component strands were first bound together, which will leave a main wire with six sub-wires radiating from it like the ribs of an umbrella.

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Take the coil of spare wire and cut off a piece of sufficient length to replace damaged portion, allowing two feet extra for making the joints. Prior to cutting this wire it is advisable to make two separate string bindings, about an inch apart, at the point where the wire is to be cut, otherwise the strands will fly out.

Prepare each end of this wire to be inserted in the manner already explained with regard to the aerial. Do the same at the other broken end of the aerial.

The actual jointing now commences. Bring one end of the aerial close up to one end of the jointing wire. Take one of the radiating sub-wires of the aerial and bend out straight along the main wire of the piece to be inserted. Then do the same with the sub-wire of the jointing wire which is next to the one just bent out flat along it, though in this case it is, of course, to be laid along the aerial wire. Do this with all of the remaining ten sub-wires, taking care to use them alternately, that is, one from the aerial and then one from the jointing wire.

Having done so, hold the jointing wire, together with the six sub-wires of the aerial, firmly in the left hand, and give any one of the wires belonging to the jointer a complete twist round the main aerial wire, making it as tight as possible. This twist must not be at right angles to the length of aerial, but nearer 45°. The best angle can only be found by experience. Now follow suit with the other five wires, utilising them in their proper order and taking care that they lie close to each other. This will give six sub-wires spirally twisted round the main aerial wire. Make as many twists as is necessary to use up the whole length of all the sub-wires. Bind the end of these twists firmly and neatly with copper binding wire, having made them as tight as possible with the aid of pliers.

The next step is to change hands and, holding the aerial in the left hand, proceed to twist the six sub-wires forming it firmly round the jointing wire in the same manner as just described, not forgetting to bind their ends well. This completes one joint.

All that remains is to go through the whole process again with the remaining two ends, which will, if carefully done, give a neat and strong joint. The greater the pull on the aerial the tighter will the joint become and therefore the better contact will be made.

The above is known as the "star joint" and is much used for lighting and power wires.

It is a good plan to practise with odd lengths of ordinary 7/18 soft copper cable before trying aerial wire, as the springiness of phosphor bronze is rather discouraging until the knack is acquired.

In case there is no time to make a star joint in the aerial, a good temporary one may be made as follows:

Cut out the damaged wire and bind up the ends of the aerial. Measure, and cut off, the jointing piece. Bring the two ends together and lay them alongside each other for about a foot. Now bind them tightly together with binding wire. A little solder will ensure a good connection and give a fairly secure joint.

Whenever soldering aerial wire always use the soldering iron in preference to the lamp, as thus only the minimum amount of heat required is used.

Avoid soldering an aerial whenever possible, as it makes the wire brittle.

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Wireless Telegraphy In the War

WIRELESS ABUSE—A TWO-EDGED WEAPON.

WHEN the Bolsheviks in December last announced their intention of immediately erecting a chain of wireless stations for the greater enlightenment of the Russian peoples and the peaceful development of the several nationalities which they hoped would become loyal components of the Russian Republic, it appeared as though these extremists had grasped one of the great possibilities of radio-telegraphy and had evolved a practical constructive programme. The news at the time of writing suggests that the Bolsheviks, in their use of wireless to date, have been playing with an edged tool, and have succeeded thereby not only in crippling themselves but in inflicting grave, if not mortal, injury upon the national life of millions whom they audaciously claimed to represent.

One of the earliest Bolshevik battle-cries was in effect a condemnation of secret diplomacy. It was cleverly timed, and following closely upon the "Willy-Nicky" and other revelations of international intrigue, gained the moral support of many whose sympathies are naturally against underground methods. The delusion, however, that the Russian Revolutionaries were about to open up a straight and wide road to common brotherhood was short-lived, for it immediately became apparent that the Bolshevik idea of "open diplomacy" embraced, amongst other things, the public abusing of those with whom diplomatic relations were intended.

The history of the war is hardly likely to contain more astonishing documentary material than the peculiarly undiplomatic addresses and Proclamations radiated by wireless from Russian Government stations during January and February of this year. Whatever the Bolsheviks had in mind when they circulated such fanatical outpourings it is difficult to imagine, but, in common parlance, they were simply asking for trouble, for, being unable like the Germans to support their insolence with force of arms, they placed themselves somewhat in the position of a schoolboy making long noses before the magisterial birch. That punishment was premeditated by the Germans was obvious, but it is unlikely that the blow was softened by the "wireless" indiscretions.

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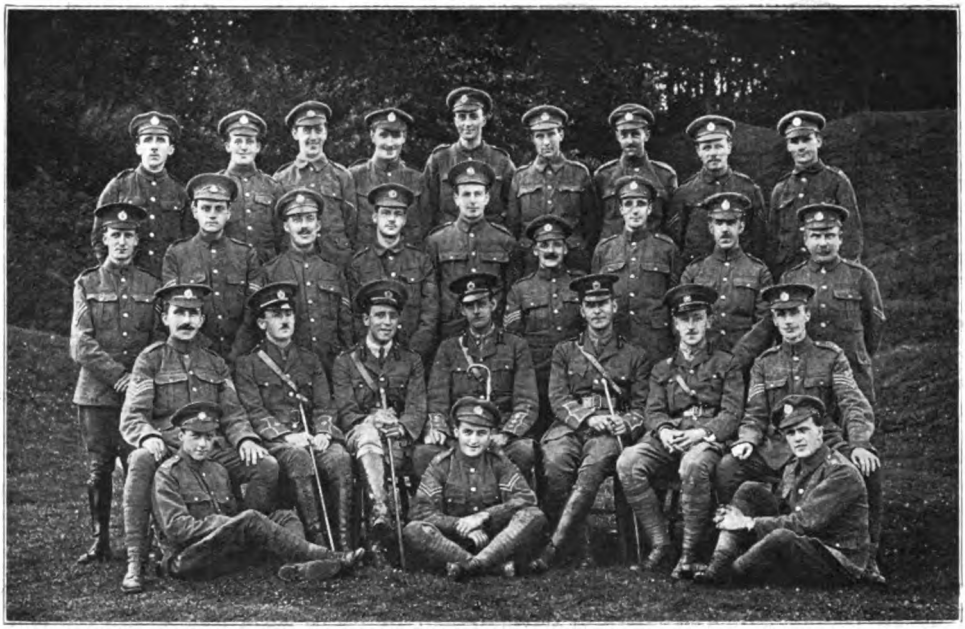

OFFICERS AND MEN AT AN IMPORTANT WIRELESS STATION "SOMEWHERE IN ENGLAND."

Why Lenin and Trotzky should have stimulated the predatory activities of the German militarists by hurling wireless abuse at the power behind the German military machine is but one of the baffling features of the Bolshevik policy. Their "wireless" appeal on February 17th for an immediate "wireless" explanation of the German "provocative telegram" of the previous day announcing a renewal of hostilities would suggest either that these men were ignorant of German psychology or that they were German agents acting a double part. Their apparent childlike belief that a "wireless" message, tantamount to the command "Halt!" would reduce the advancing German hordes to marking time is equally astounding, and the one lesson which they must have learned is, that whereas wireless can provide a means of instant communication even between belligerent nations, radiotelegraphy cannot of its own power effect an instant and accommodating reply. On the other hand, these wireless demands undoubtedly embarrassed the Germans, who, taxed to find a means of delaying their replies whilst their troops "made good" on enemy soil, had to resort, first of all, to the excuse that a wireless message could not be regarded as an official document, and later, when the signatures arrived by special messenger, to the explanation that the deliberations upon the Note of reply would necessarily occupy a few days. What happened during the few days is now well known. The moral of the episode is that for the satisfactory development of the great and valuable medium for international intercourse which wireless affords, a special training of the imaginative faculties is required. The Bolshevik imaginings were concentrated upon the exotic clothing of their abuse.

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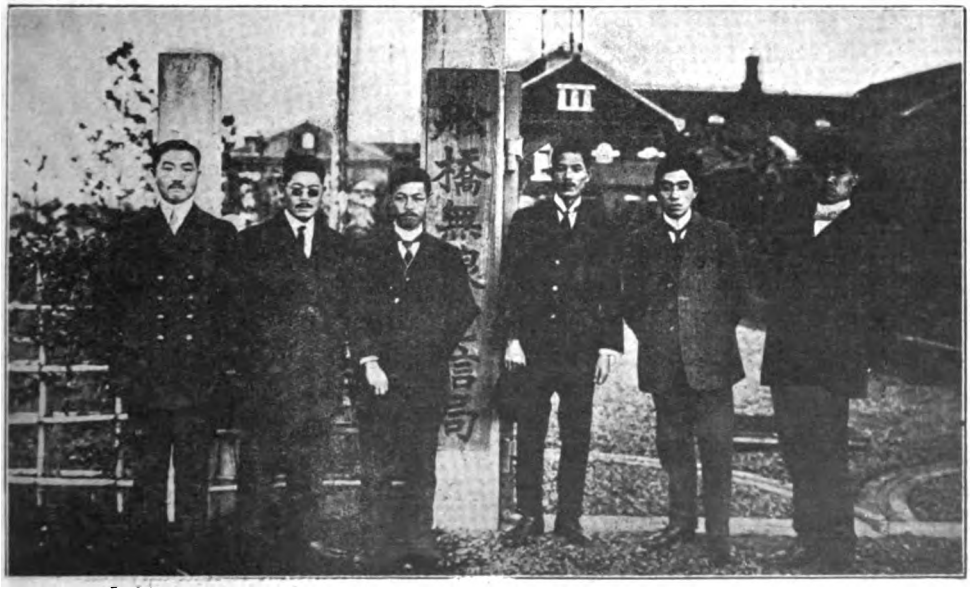
"Armed" with Wireless: a Typical Adventure.

Amongst the several excellent stories of British pluck *versus* German U-boat piracy which the Admiralty have wisely considered worthy of publicity was one told recently in the *Yorkshire Observer* by a well-informed writer hiding his identity beneath the pen-name "Ajax." Relating the adventures of two steamers, one of which was armed and detailed to protect her "sister," he tells how the armed ship—armed with a gun that is—ran into the danger zone of a submarine and received a hit from a torpedo. The crew, with the exception of the master and his two gunners, drew away, under instructions, in the ship's boat. The unarmed vessel, meanwhile manœuvring for safety, made off according to previous arrangement. The fight between the three men on the sinking vessel and the submarine proved an unequal one, for the submarine with its greater mobility was able at the end of half an hour's duelling to get home a second torpedo, leaving the plucky master and his gunners no alternative but to take to the emergency boat and await help. This happily was ultimately forthcoming, for the sister ship happened also to be armed—not with guns, but that very useful weapon, "wireless," and when the first torpedo found its billet the Marconi man also went into action with the regulation appeals for assistance. These were picked up by an American destroyer, which, with an alertness characteristic of the naval service of our cousins, steamed at full speed to the spot. The U-boat and its victim were gone, but the gallant seamen were rescued. The unarmed vessel reached its destination without further incident. No better illustration has been furnished of effective co-operation between two boats unequally protected against the hidden foe. We can thoroughly understand that



THE OPERATING STAFF AT FUNABASHI WIRELESS STATION, JAPAN, NOW ENGAGED ON IMPORTANT WAR WORK.

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additional sense of security which all feel who go to sea in these days with a Marconi man and his mysterious "box of tricks."

WIRELESS CLUE TO "LUSITANIA" CRIME.

Students of criminology tell us that experience reveals a surprising inability on the part of the habitual evil-doer to completely cover up his tracks, so that in such instances where crimes remain unsolved the fault lies rather in the lack of ingenuity or persistence on the part of the investigators. The criminal history of the German nation appears closely to follow that of individuals in this characteristic weakness, for day by day facts are being laid bare before the whole world which certainly were not "intended for publication" by their fiendish authors. It will be remembered that when the *Lusitania* was sent to the bottom with its numerous innocent souls the German Government whilst permitting "irresponsible folk" to celebrate the massacre by the striking of a medal, took care officially to suggest that if the loss were due to submarine activity, the U-boat commander responsible for the deed had acted off his own bat and not under instructions from the Wilhelmstrasse.

Whilst few persons have had any doubt as to the real authors of this unspeakable outrage upon humanity it has taken nearly three years to give to history undisputed evidence of the German Government's direct guilt, and this, if the whole story has been told, has only been possible through systematic investigations of wireless enthusiasts attached to the staff of the *Providence Journal* working under the direction of the editor, Mr. John R. Rathom.

On the morning of April 29th, 1915, Mr. Rathom's assistants, who were listening to a Nauen programme, intercepted the following:

"From Berlin Foreign Office.

"To Botschaft, Washington.

"669 (44-W) Welt nineteen-fifteen warne 175 29 1 stop 175 1 2 stop durch "622 2 4 stop 19 7 18 stop LIX 11 3 4 5 6." Now this obvious code bore no resemblance to the "Father dead" or other types of secret messages which had so often been flashed abroad from Nauen, and for a while the self-appointed detectives were puzzled. Later on, however, when the disaster to the *Lusitania* became known and American interest in all things German became intensified, the *Providence Journal* investigators learned that Prince Hatzfeldt, of the German Embassy staff, spent part of the morning of April 29th, 1915, hunting for a copy of the *New York World* Almanac for 1915. This fact provided the much sought-for key, for the pages, lines and words of the "Welt" Almanac indicated by the figures given above, provided the following transcription:

"Warn *Lusitania* passenger(s) through Press not voyage across the Atlantic."

The German Ambassador, it will be remembered, admitted the publication of an advertisement in the New York papers but denied that it had any particular reference to the *Lusitania*. How much truth can be attached to that statement is revealed, firstly, through the present exposure of the coded message from Nauen.

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and secondly, from his action in giving a dinner in New York to celebrate the crime on the very evening when he declared to the American Press that he was overwhelmed with grief at the great Cunarder's fate. Is there still in the whole world any honest man who is prepared to defend the arch-rogues of Central Europe ?

Wireless Warfare in Oxford Street.

If the coded wireless message of that April morning in 1915 condemns for all time the exalted murderers of the Berlin Court, another much more recent and more easily understood communication through the same channel has indicated a continued intent to deceive. In the second week of February England was made to rock with laughter by a German wireless story for neutral consumption of an alleged riot in Oxford Street, London. The wily director of Hun propaganda, with the double purpose of impressing the world with the authenticity of the story and of providing a loophole should he be caught out in his facts, credited the details to his Amsterdam correspondent. For the benefit of our readers who, being at sea or otherwise engaged, did not read the message when published in the newspapers, we reproduce it here in its entirety.

" During the whole of January the strikes in England have led to numerous " riots and scenes in the streets. Hardly a day passed during the month without " the crowd coming into conflict with the police in English towns. Concerning one of " these riots which took place in London on January 17th and which is typical of " the state of affairs in England, our Amsterdam correspondent gives the following " details :

" On January 17th at 3 p.m. there was a conflict between the police and the " crowd, in which the police had the worst of it and were put to flight. Then a " detachment of Scotch recruits who were in barracks at Sheper Bush (Shepherd's " Bush ?) were summoned to their assistance. When they reached Oxford Street, " where the principal fighting between the crowd and the police took place, and " the soldiers were ordered to fire, the majority of them refused, and about 80 men " were arrested and taken to the prison of Old Bailey. At Selfridge's great shop " in Oxford Street all the windows were broken in the riot. In the evening there " were other tumults near Threadneedle Street."

Now the Amsterdam correspondent of the Berlin Department of Information, so " thoroughly informed " regarding time and place of this highly entertaining episode, omitted one or two details which might perhaps have carried conviction for those who, not knowing London, are " given to thought," even when dealing with Berlin wireless. Seeing that the police had been put to flight there is no clue as to the forces employed for the arrest and incarceration of the " Jocks " from " Sheper Bush " in a jail which ceased to exist long before the war, neither have we information on that point of legitimate curiosity, namely, the number of casualties caused by that minority of kilted " rookies " who did not refuse to fire. Somehow the laugh which echoed throughout the country when the story was told over here has aroused suspicion in the German provinces, for certain German journals have been at pains to explain that this pretty little legend was not radiated by wireless at all, but was concocted here, presumably as a spare-time effort, by British spies.

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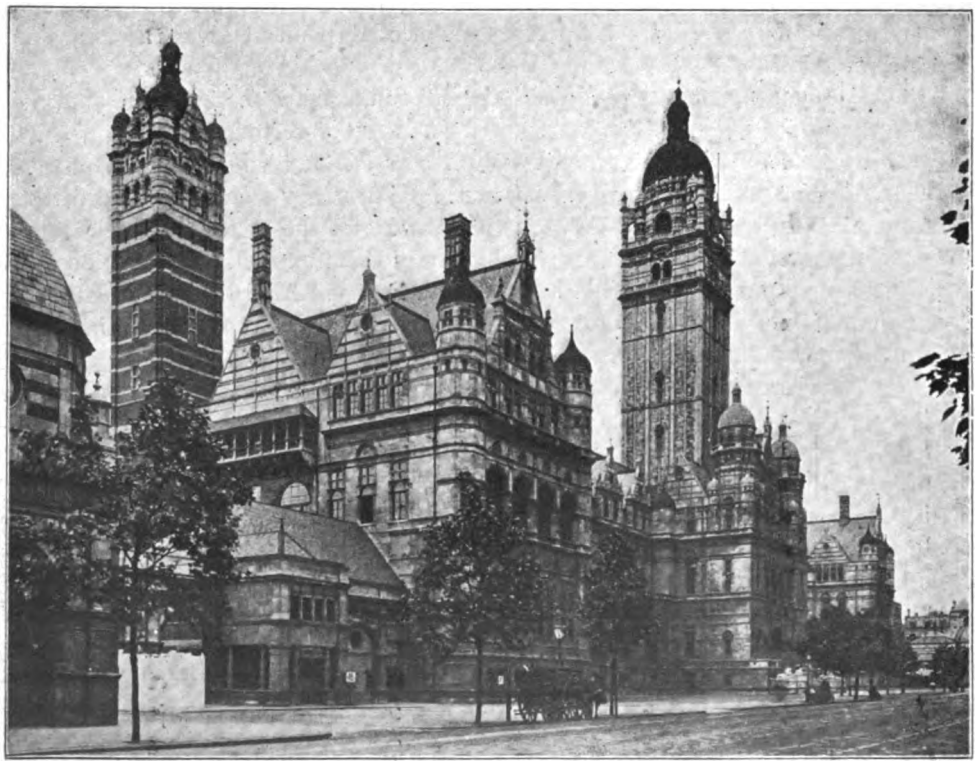
The Science Museum at South Kensington

Exhibits of Interest to the Wireless Student

FEW students of wireless telegraphy now resident in London are aware that there exists in the Science Division of the Victoria and Albert Museum at South Kensington a collection of electrical apparatus, the examination of which would prove of the greatest value to them in their studies. In normal times these galleries are open every weekday, but at present the electrical section—the part of particular interest to our readers—is open only on Thursday and Friday between the hours of 2 p.m. and 4.45 p.m. Needless to say admission is free and the exhibits are so well described and labelled that there is no need to purchase a catalogue.

The visitor to the Science Museum should make his way first to the South Kensington "Underground" Station (District Railway or Piccadilly and Brompton Tube), and thence walk up Exhibition Road to Imperial Institute Road, a turning



IMPERIAL INSTITUTE, SOUTH KENSINGTON.

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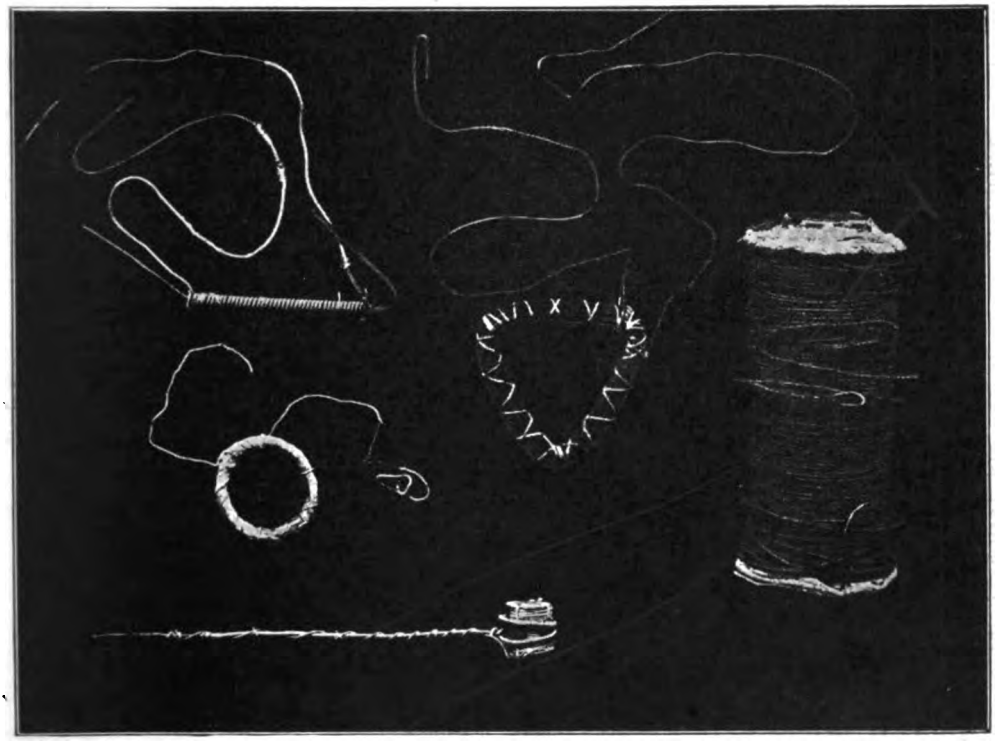

COILS USED BY FARADAY.

to the left, some five minutes' walk along the former thoroughfare. The Imperial Institute, a photograph of which is reproduced in this article, is easily found, the central tower being a landmark of South Kensington. The Science Museum occupies galleries on both sides of Imperial Institute Road, the entrance to the Western Galleries being to the extreme left of the photograph, the word "Division" in the illustration being a part of the "Science Division." Just opposite this entrance are the Southern Galleries, for which the student should aim. The Electrical Room is at the top of the staircase immediately facing the visitor on his entry.

There are few exhibits of actual wireless apparatus in this room, but many which can be profitably studied by the student endeavouring to obtain a good groundwork of electricity and magnetism. Students of high tension electricity will be interested in the splendid exhibit of Frictional and Wimshurst machines, a giant example of the latter being one of the first objects seen. This machine, which has two huge glass plates each 7 feet in diameter, will generate a 14-inch spark and was constructed by Wimshurst himself. In a near-by case a much more compact, although equally powerful, instrument consists of twelve plates, 2 feet 6 inches in diameter. The Wimshurst machine is an instrument of which the construction can be understood far more easily by examination than by any number of diagrams, and five minutes spent before this case will probably serve to clear up a host of difficulties. To those who wish to understand the construction of various forms of measuring instruments

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such as ammeters, voltmeters and the like, there is a splendidly arranged collection of instruments, many of them in pieces or in sections. In particular we would mention a series of hot wire ammeters. Accumulators, too, are clearly explained, and wall cases show the various parts of chloride and other cells in process of manufacture. There is no better method of explaining the construction of an accumulator than to show the student the various parts in process of manufacture, and, seeing that the chloride cell is largely used in wireless work, this exhibit should be carefully studied.

In the section devoted to induction coils and transformers will be found a representative section of various forms of interrupter, including the vibrating, mercury jet, and electrolytic types. It may be mentioned that there are at least three forms of Wehnelt Brake at present on view.

Not the least interesting of the exhibits is a full-sized model of a table used by the famous French electrician Ampère for research and lecture work, and near by will be found a collection of some of the original coils used by Faraday. If they serve no other purpose these exhibits will show the student that the best work of some of the greatest scientists has been done with the crudest and simplest apparatus, and that it is not necessary to be equipped with elaborate apparatus to make important discoveries. The actual apparatus used by many other famous men is also on view and the wireless student should particularly note the first shunted field dynamo made by Wheatstone and the first series wound machine made by Siemens. Particular interest also attaches to the first alternator made by Ferranti, to be found not many yards away.

EARLY INDUCTION COIL.

Visitors who wish to trace the history of the wire telegraph will find an unrivalled collection of original apparatus dating right back from the time of Morse and Lindsay. Our remark above concerning the simplicity of the apparatus

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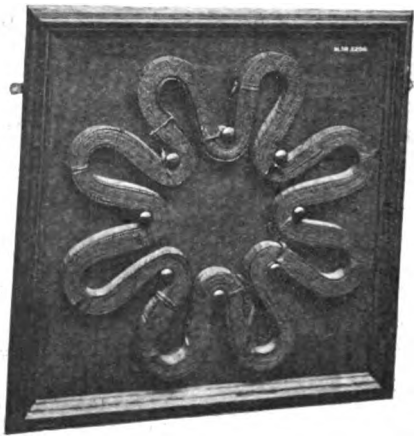
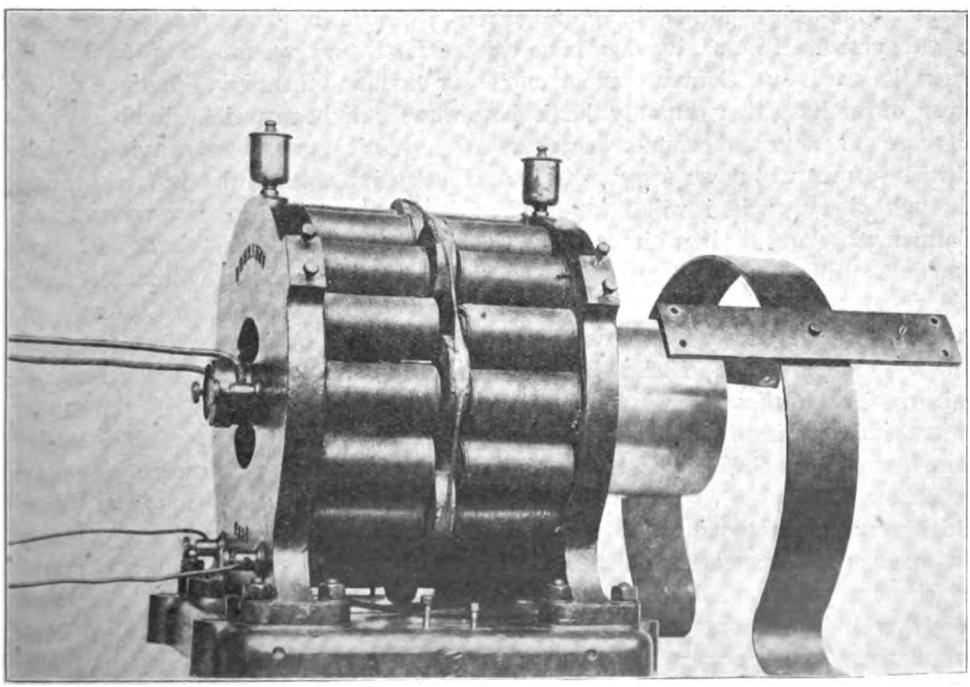
used by great inventors will be found to apply equally to that of Morse and the workers who followed him in his researches.

The telegraph apparatus illustrated on pages 830 and 831 of our March issue can be examined in the original and the gradual improvement through succeeding years traced progressively, and a recent addition to the collection is the apparatus constructed by Mr. Duddell and illustrated in our January issue, pages 673 and 676.



ROTOR WINDING OF THE FIRST ALTERNATOR.

In view of the completeness of the wire telegraph and telephone sections of the exhibits, it is somewhat surprising to find that radiotelegraphy is given but one small case. Here we find a Fleming Cymometer, an early Marconi Coherer Set, a small Demonstration Transmitter and Receiver and a model of the Magnetic Detector. In order to make the collection representative, many more wireless exhibits should obviously be added, and we trust that as soon as conditions permit this question will be looked into by the Museum authorities.



THE FIRST ALTERNATOR.

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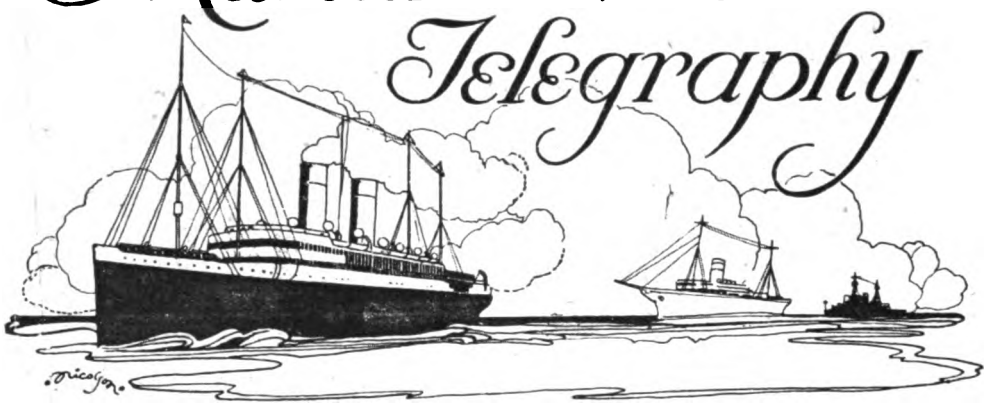
Maritime Wireless Telegraphy



THE SEVENTH HOSPITAL SHIP.

IF there is any special significance to be attached to the number "7" the German Admiralty should be experiencing an innate uneasiness, for they have now definitely registered on their infamous records the sinking of seven British hospital ships. As by a desperate decision to sink at sight any vessel suspected of carrying munitions of war the German Government merely succeeded in bringing into conflict against them a most formidable group of foes, so, by these ghoulish attacks on the sacred symbols of humanity they have created for themselves a lasting shame. If when the war is over Germans of high and lowly birth find themselves shunned as the lepers of the East, they can only thank those who for slight material gain abandoned all sense of honour and common decency. We have oft repeated the conviction that British seamen will never forget, and if retribution is not immediately forthcoming through other agencies it will ultimately be found in the ostracism of every wretched German who dares to show himself upon the high seas. The *Glenart Castle*, although unable to utilise her wireless when she succumbed to this foul and inhuman attack, did on at least one occasion make a material contribution to the triumphs of radiotelegraphy. Early in the war, when known as the *Galician*, she was stopped off the Canaries by the *Kaiser Wilhelm der Grosse*, then engaged as a commerce raider. The *Galician's* wireless operator sent the usual "SOS," but was threatened with immediate sinking if he tapped out another signal. The Germans then boarded the *Galician*, destroyed the wireless apparatus and ordered the ship to follow the raider. The broken message, however, had taken effect. Two British cruisers hastened to the rescue and the *Kaiser Wilhelm der Grosse*, hearing an exchange of messages between these warships, made off with all the speed which she possessed. Shortly afterwards she encountered the light cruiser *Highflyer* and was sent to the bottom. The *Highflyer* received "wireless congratulations" on her prowess. Happily we are able to record the safety of the *Glenart Castle's* operator.

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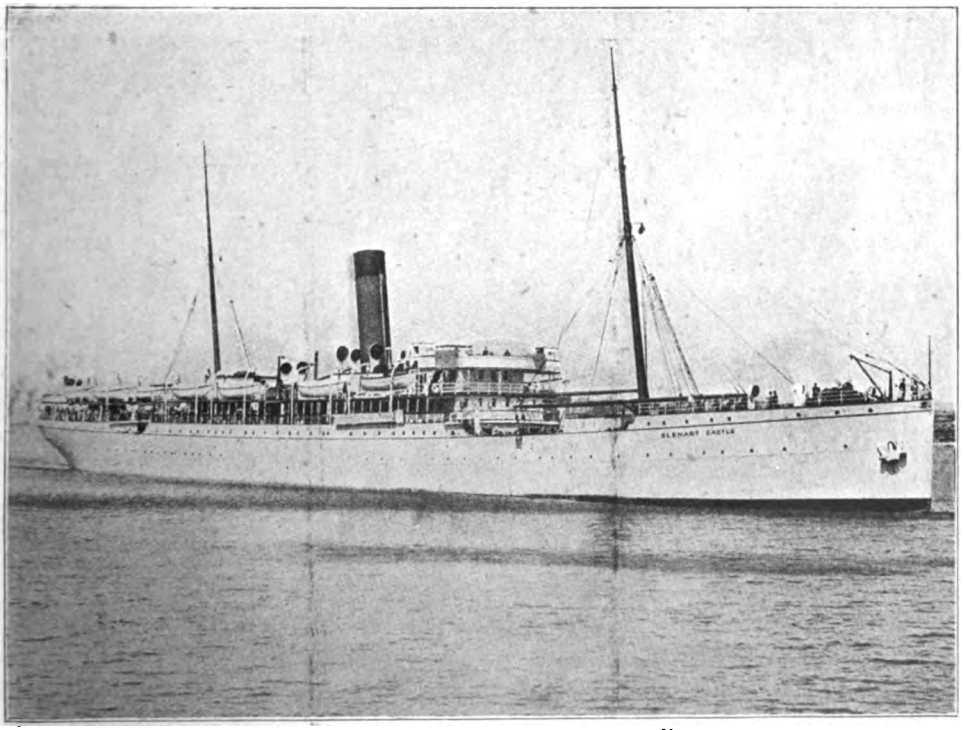
A FINE SAVE: THE TUSCANIA'S "SOS."

It is gratifying that "wireless" played so effective a part in saving the great majority of the American troops which were aboard the Allan liner *Tuscania* when she was torpedoed off the coast of Ireland early in February. This fine boat, the first, and let us hope the last, American transport to be torpedoed, was completed on the Clyde early in the war. She was fitted with every modern appliance securing comfort and relative safety. Thanks to the wireless signals sent out by the emergency apparatus, British escorts and patrol vessels were able to save 2,187 out of the 2,397 souls aboard. The attack on this ship took place under the cover of darkness, when presumably the Germans expected a maximum of confusion; but all reports show that despite the fact that many of the troops aboard had not seen the sea until they left the American port they behaved with traditional courage and stoicism, lining up on board, and singing their national airs whilst standing as on parade. Such lives as were lost, apart from the direct effects of the explosion, were caused by a natural anxiety on the part of a few to get clear when the ship took an ugly list. Even this effort by the Germans will not be without its reflex action, for some two thousand officers and men have gone to France with personal accounts to settle against the Huns. To use an American's own words, "Our hearts are steeled."

WRECKED OFF CAPE RACE.

The loss of the Red Cross Line steamship *Florizel*, off the rugged coast of New-



THE TORPEDOED HOSPITAL SHIP "GLENART CASTLE" IN PRE-WAR DAYS.

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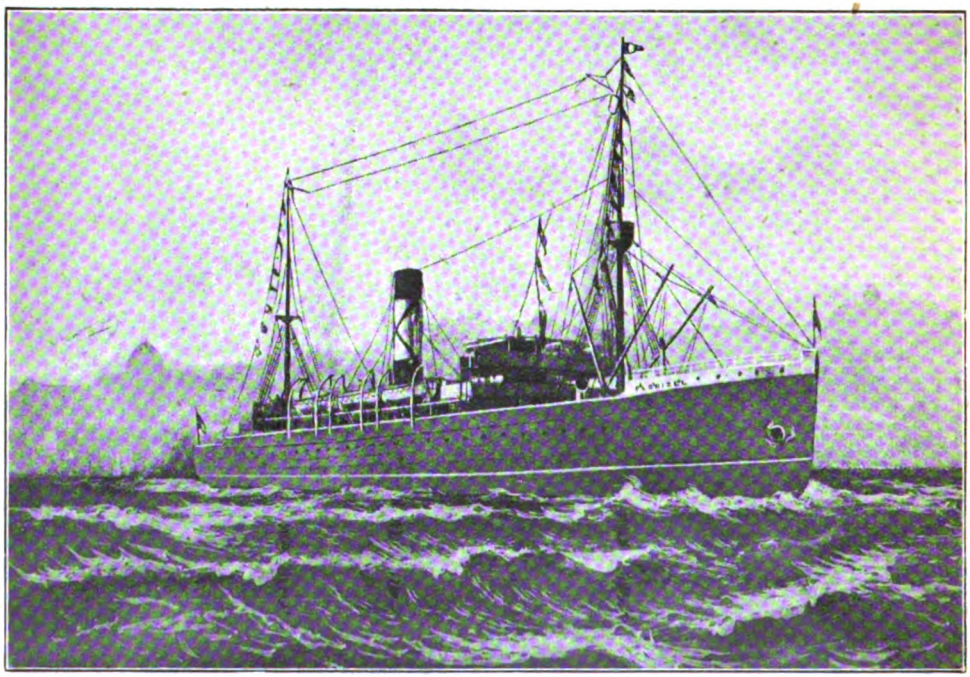
foundland, during a gale, towards the end of February, is a disaster which, quite apart from the heavy list of casualties, will have been noted with particular regret by Marconi men. No ship was more at home in Newfoundland waters, for, although at the time of the catastrophe she was carrying passengers from St. Johns to New York, she had contributed materially to the prosperity of the Island Colony by a singularly successful career as a sealing vessel. The *Florizel* was one of four steel ships built in 1909 for the Newfoundland seal fisheries. She was the largest of the four, and her owners, Messrs. Bowring Brothers, with commendable foresight, decided to equip her with wireless. As the pioneer boat in this direction she proved so useful that in the following year other ships engaged in this particular industry were similarly fitted. Some data regarding the vessel appeared in the very first number of the *Marconigraph*, the wireless monthly from which THE WIRELESS WORLD was evolved, and an account of a sealing voyage made by the then Marconi officer, Mr. Ernest T. Fisk (now managing director of the Amalgamated Wireless (Australasia), Ltd.), in 1910, appeared in the second issue, of May, 1911. On that voyage 30,488 seals were captured, and the success was notified to the owners through the Marconi station at Cape Race. The same wireless equipment did good service to the last, for the fact that the ship had gone ashore was announced by a single wireless meassge. Happily the Marconi operator, Mr. Cecil S. Carter, was rescued, so that we hope, in due course, to be able to give to our readers some details of the catastrophe, which came as a heavy blow to the people of St. Johns.



S.S. "FLORIZEL" LEAVING ST. JOHNS, NEWFOUNDLAND.

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THE RETURN OF THE "WOLF": VICTIMS LACKING WIRELESS.

Towards the end of February; when the German Government was assembling the machinery for a new war loan campaign, there was flashed abroad one morning by wireless, and the usual channels in Copenhagen, Amsterdam and Zurich, news of the return of a buccaneering auxiliary cruiser, the *Wolf*, which according to the official report had been careering about the Indian, Pacific and Atlantic Oceans for a period of fifteen months, sinking merchantmen, seizing stores and making prisoners. To assist her in her risky business the *Wolf* fitted out one or more of her captures for special purposes such as mine laying or decoy work, but so far as has yet been made known all her auxiliaries came to grief. The *Turritella* was sunk by her own crew on encountering a British warship, and the *Igotz Mendi*, a Spanish vessel, captured and detailed to return to Germany with prisoners and stores, ran ashore off Jutland when within a day's steaming of Kiel. The German Government, of course, quite unable to allow a straightforward record of daring seamanship to stand on its own merits, preferred to spoil the whole affair by circulating deliberate falsehoods. Not satisfied with a claim to have destroyed 35 enemy vessels with an aggregate tonnage of at least 210,000, they added to this modest total the Japanese super-dreadnought *Haruna* of 28,000 tons and the suggestion that a British or Japanese cruiser had also been badly damaged. The story was duly radiated by "wireless" with the hope that an impression might be created amongst all the belligerent countries. But once again the lying character of the German propaganda reacted upon its authors, for on the receipt of the German claims in London, the British Admiralty and the Japanese Naval Attaché were able to show that no British nor Japanese cruiser was in any way damaged during the cruises of this boat.

It may therefore be safely assumed that the total tonnage claimed by the German Admiralty is equally fictitious and the greater part of the story open to suspicion.

The fact remains that the *Wolf*, by fair means or foul, successfully evaded our cordon of outposts, and, during the course of several months accounted for at least eleven boats, three of which were American sailing vessels and one an English sailing vessel. It is interesting to note that of the eleven "possibles" published by the Admiralty the majority, so far as we have been able to ascertain, were not fitted with wireless. Had they been so fitted, even making allowance for the cunning of the German commander, it is extremely unlikely that they would all have been captured. On the other hand it is highly probable that the *Wolf* itself would have been cornered. When one realises the superhuman task which has been set the British Navy in keeping the seas free from such adventurous craft it is wonderful testimony to British thoroughness that during the three and a half years of war only three or four ships of this character have been able to leave harbour and return. It is not the policy of the British Admiralty to proclaim all its deeds on the housetops. Perhaps when the war is over the Germans may learn something of the fate of other ships which have ventured abroad on similar errands.

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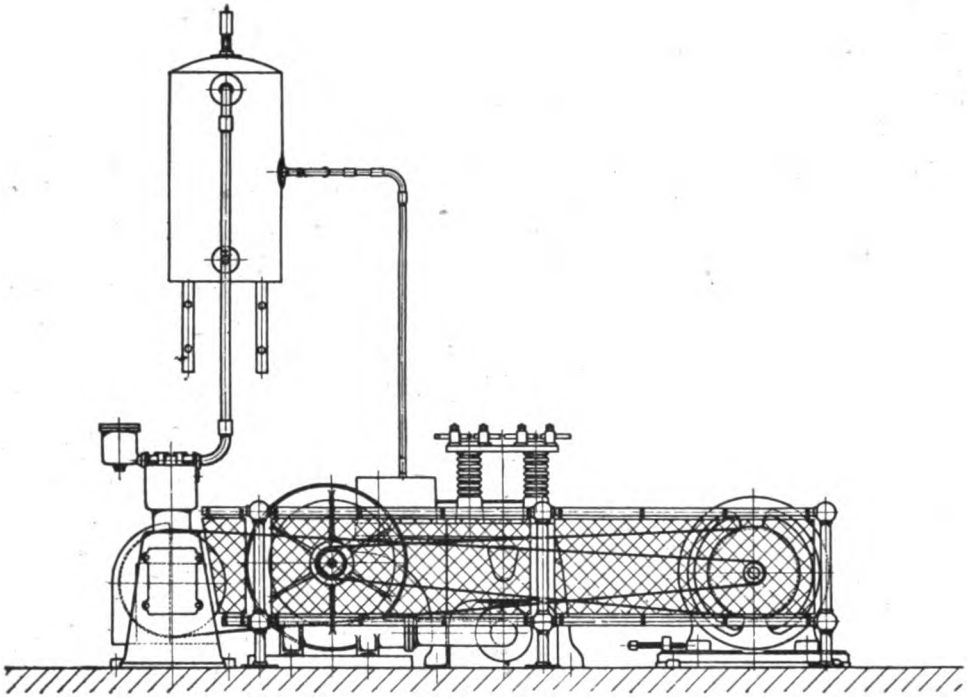
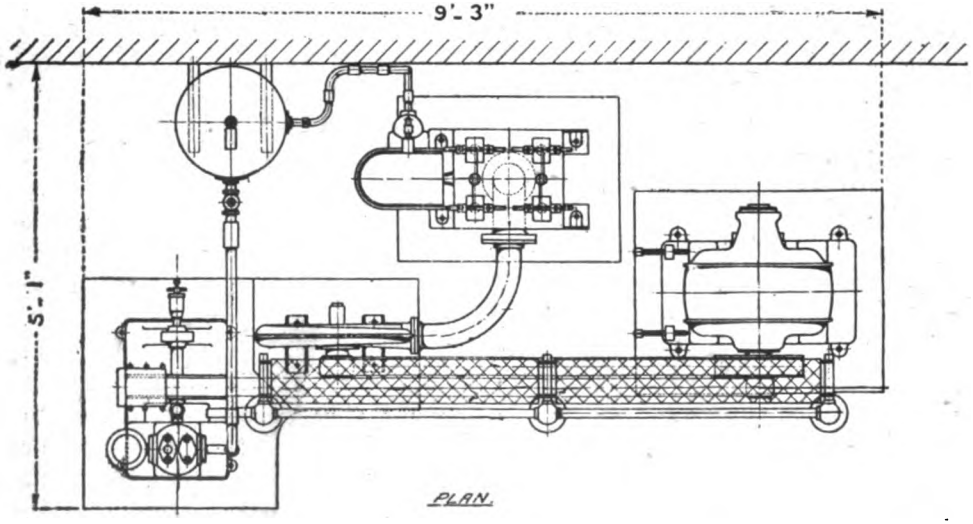


FRONT ELEVATION.



PLAN.

Apparatus for High-Speed

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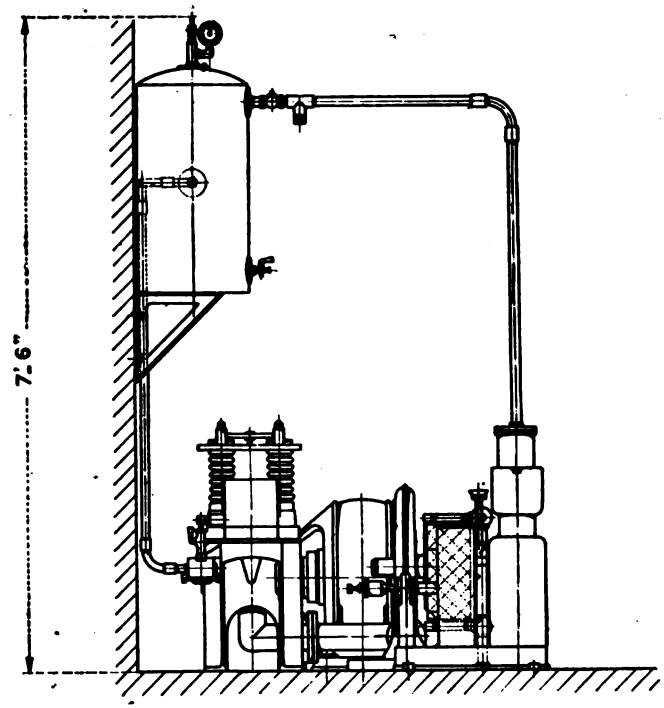
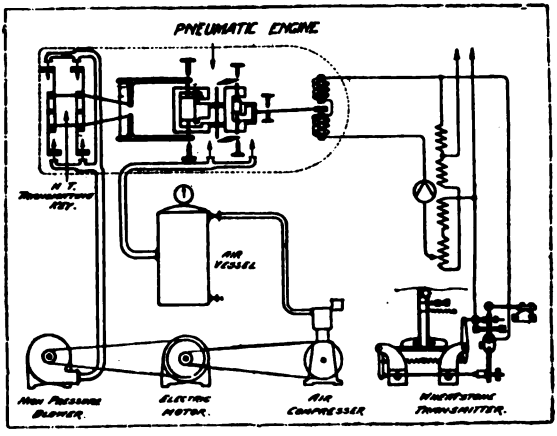


END ELEVATION.



EXPLANATORY DIAGRAM.

Wireless Transmission (see page 51).

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Notes of the Month

New Master of Trinity: A Score for Science.

The appointment of Sir Joseph Thomson to the important post of Master of Trinity, Cambridge, is a matter of great interest to the world of wireless and is directly, we should imagine, the outcome of the lessons of the war. The famous Cavendish Professor of Physics, a worthy successor to the Chair once so ably filled by Clerk Maxwell, to whom radiotelegraphy is indebted for much of its basic theory, has himself contributed materially to the newer theories associated with certain electrical phenomena; in fact, before his award of the Nobel Prize for Physics in 1906 he had published volumes on "The Elements of Mathematical Theory of Electricity and Magnetism" and "The Discharge of Electricity through Gases." Cambridge has long taken a lead amongst the ancient universities in matters scientific, and it would appear that the national necessity for a much wider recognition of science by these important institutions, and the awakening of Oxford to studies of this character, has aroused amongst the learned professors on the Cam a determination to make even greater departures on the modern side of academic study. We trust that the new Master of the great Tudor Foundation, which proudly includes amongst its *alumni* Newton and other distinguished philosophers, will give such a place to the study of wireless as will assist in maintaining for this country a pre-eminence in its practical development.

Marconi Free Training: Some Misapprehensions.

We should like to take this opportunity of correcting a false impression which has spread abroad, apparently as the result of the great success of the recent call for wireless operators. In order to meet the urgent national need for wireless men in the mercantile and allied services the Marconi Company at considerable expense to itself instituted a system of free training, with guaranteed appointments to men who had attained proficiency. The result of this daring experiment has been eminently successful not only in securing large numbers of candidates but in opening the service to many keen and intelligent young fellows who, residing many miles distant from a training centre, would have been prevented from entering upon a wireless career. The exceptional needs of the moment had to be met by exceptional methods, but because the Marconi Company is still offering "free training" it does not necessarily follow that this offer will remain open indefinitely, and such intending

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operators as think that "any time will do," provided they are on the right side of eighteen, will be well advised not to build hopes on a continuance of the facilities now afforded. On the other hand, if there are any hanging back under the impression that "free training" means an inferior training we hope that the following arguments, which should be obvious to all, will at once dispel this idea. Firstly, at a time like this, when every fit man that can possibly be spared is required in the fighting line, the authorities are not going to release anyone from military service who is not proven to be expert in his profession, so that the standard of proficiency, and consequently the thoroughness of the training curriculum, is in all cases maintained at least to the peace-time standard. Also the needs of the moment are such that men passed into the service must be proficient beyond dispute and certain of maintaining the high tradition of the Marconi Company and doing justice to that Company's apparatus.

"HIDDEN SCIENCE" IN SOUTH KENSINGTON.

There are not a few amongst the scientifically inclined of London's millions who will have welcomed the reopening of the Science Museum at South Kensington. We are totally at a loss to understand why the Government ever arrived at the decision that it was in the national interest, particularly at a time like the present, when the study of applied science has received such impetus, to veil from public view our classic milestones on the path of invention and discovery. Fortunately someone has been found who in these topsy-turvy times can think the right way up and has not to stand on his head to carry out the mental processes. We would suggest, however, to this unknown benefactor that there is room for further improvement in the changes recently effected and that the Electrical Department of the Science Department at Kensington should be open on Saturdays as well as Thursdays and Fridays as at present arranged. Speaking for wireless men to whom all branches of electrical science provide a very keen interest we know that there are very few, particularly amongst the students, who can get as far as South Kensington on any day but Saturday and then only in the afternoons.

"IN THE AIR"—A GERMAN ELECTRICAL BARRICADE.

During a lull in the bombing attacks on London towards the end of 1917 many fantastic stories spread amongst the ignorant as to precautions alleged to have been taken by those responsible for the aerial defence of the metropolis against enemy raiders. Although we have hitherto sought in vain for a sense of humour amongst our Teuton enemies it would appear that they, having learned something of the credulity of the masses respecting anything outside the limits of direct observation, had determined to follow up the London rumours with a few of their own. Anyhow, some of the most responsible English dailies despite an obvious shortage of space for serious news, found room during the first week in March for an Amsterdam report on new Hun methods for catching such of our airmen as dare to give practical demonstrations over German cities of the type of aerial warfare which the German public has hitherto professed to appreciate. We are told that towards evening the Germans

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send up twenty captive balloons and attached to these are electrified steel cables. "The electric barrier thus created is claimed to constitute a danger to all airmen coming in contact with it." . . . (Interval for refreshments.) . . . Perhaps some night one of our aviators, in his dreams, will take a Lewis gun and bring down those twenty balloons with their network of electrical impedimenta and quietly electrocute the Germans sleeping so composedly beneath their novel barricade. Then, of course, someone, the aviator or the inventor of the fantasy, will wake up. The legend, which, of course, would be valueless without some reference to "electricity," recalls the story, told—dare we say it—against a British Government Department which, before the war, agreed to certain trials on the East Coast of an invention wherein "wireless "waves were to be utilised to magnetise the pistons of aero engines, cause them to "seize" and bring the helpless aviator to earth. The "inventor," if we remember rightly, used the occasion as an opportunity for making off with certain Government property, and to this day the trials, like the German electrical barricade, are still "in the air."

ENCOURAGEMENT OF INVENTORS.

The Marconi Company has recently formulated an excellent scheme for the encouragement of embryo inventors on its staffs. According to the new arrangement, every invention submitted by a member of the staff and adopted by the Company will be paid for in cash; a minimum sum of £10 to be paid on the Company taking out a provisional patent, and a further sum to be paid if the Company proceeds with the patent and considers the invention of value. This second sum will, of course, be dependent entirely upon the adjudged value of the invention.

On the subject of inventions, we notice that some valuable remarks were recently made by Captain W. S. Smith, of the United States Navy, in a lecture to the Engineers' Club of Philadelphia. His subject was inventions relative to war material, and he successfully disposed of the idea that the war will be won by any *one* great new invention. He wisely pointed out that all profitable invention is no more than prudent development of what has preceded it, and told his audience that the usual method is to divide an invention into ten parts. The inventor comes with one, and if he cannot harmonise with the other nine, his invention is not worth it. Captain Smith gives the example of a man who brought forward a new device for guiding torpedoes. It had to be pointed out to him that the design of all existing torpedoes would have to be changed to meet the requirements of his invention. A torpedo is the development of years of study, and just in order to put a little thing on the torpedo it would have been necessary to start from where they had begun and build the torpedo up to the inventor's ideas.

Wireless inventors would do well to consider their inventions from this point of view, for it is obvious that no commercial company can "scrap" thousands of pounds' worth of apparatus for the purpose of introducing a very minor improvement.

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Some Curves and Nomograms for Wireless Calculations

By P. BAILLIE, L.Sc.

IT is the purpose of the present paper to give several examples of graphical calculations. Similar examples have already been published in these columns. Several new nomograms will be given hereafter, in view of their application to radio stations design. Though the matter of design has already been competently dealt with by Lieut. Bertram Hoyle, M.Sc.,* certain formulæ will be quoted again for the sake of completeness. A number of curves will be given which it is hoped will shorten and facilitate numerical calculations.

First of all, a value I_R of the mean current in receiving antenna must be assumed, to obtain fair signals.

According to Professor Fleming,† this value may be estimated as 40 micro-amperes. Captain Chenevix Trench, discussing Dr. Austin's tests, admits a smaller value.‡ Of course, figures much below should be adopted when using amplifiers. A value has also to be assumed for the wave-length; the best wave-length to be used is given by §

$$\lambda \text{ (metres)} = 250 \cdot a^2 \cdot d^2 \text{ (kilometres)} \quad . \quad . \quad . \quad (1)$$

where a is the absorption coefficient = 0,0015.

Curve Fig. 1 gives the best value of the wave-length in terms of distance d.

It is obvious that the use of the best wave-length is not always practicable.

The mean current I_s in sending antenna is obtained from Dr. Austin's formula:

$$\frac{I_R}{I_s} = 4{,}251 \cdot \frac{h_R\, h_S}{\lambda\, d} \cdot e^{-\frac{0.0015 \cdot d}{\sqrt{\lambda}}}$$

All the lengths are in kilometres.

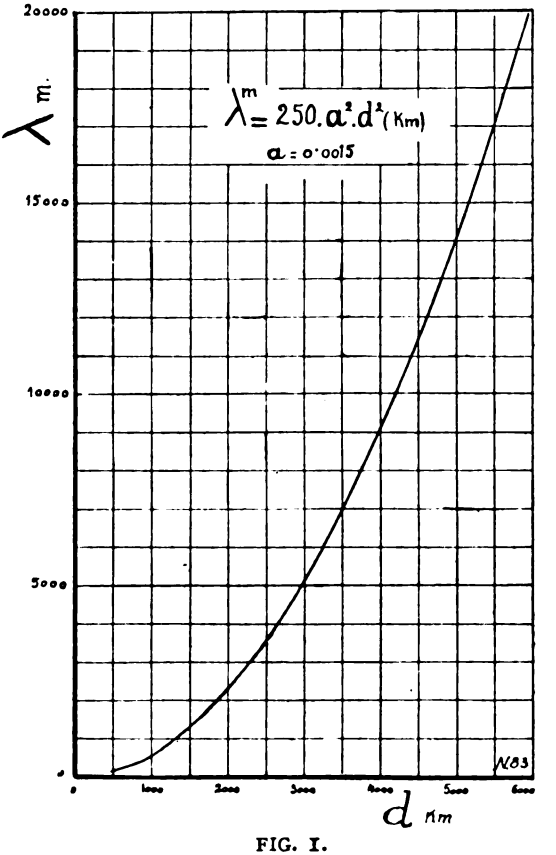

FIG. 1.

* See THE WIRELESS WORLD, March to July, 1917.
† *Wireless Telegraphist's Pocket Book*, page 233.
‡ *The Electrician*, Vol. LXXIX., April 20th to May 4th, 1917.
§ See THE WIRELESS WORLD, Vol. II., page 552.

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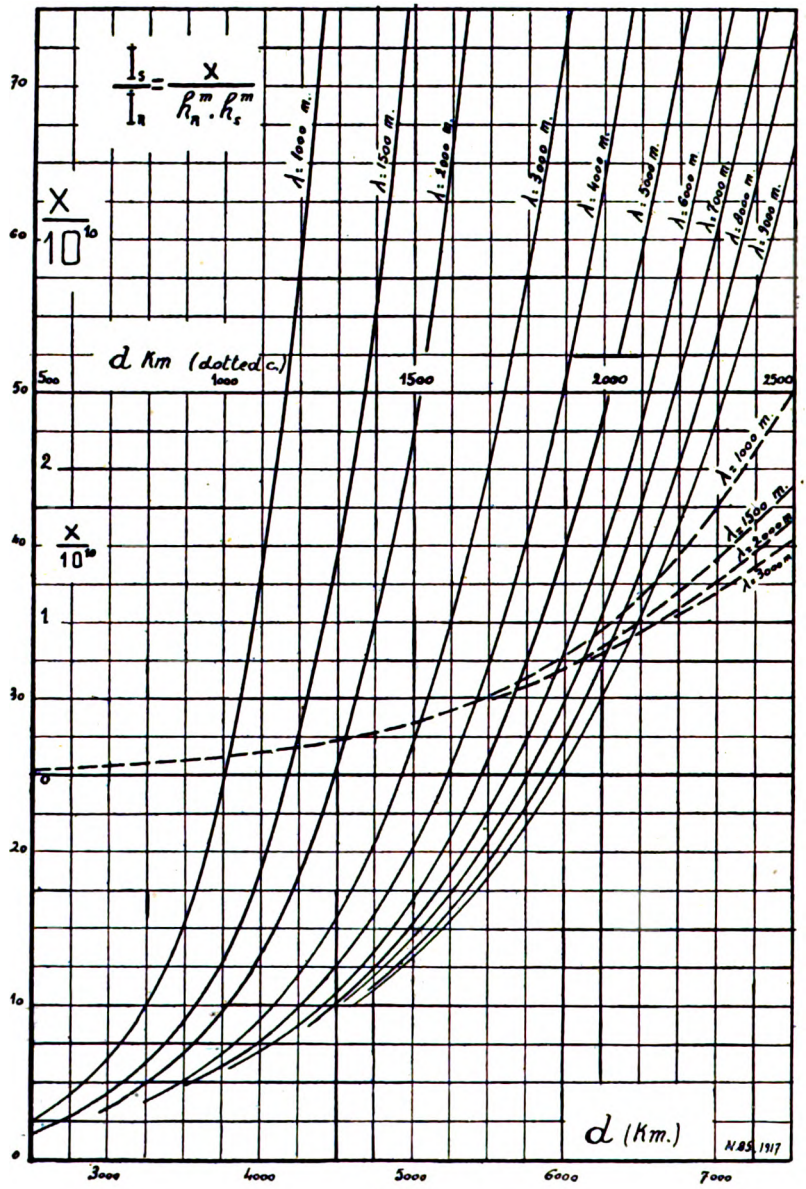

FIG. 2.

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Curves Fig. 2 give values of factor $X=\frac{10^6}{4,251}\cdot\lambda\cdot d\cdot e^{\frac{0,0015\cdot d}{\sqrt{\lambda}}}$ in terms of d (kilometres) and λ (metres):

Thus $$\frac{I_s}{I_R}=\frac{X}{h_R h_s}\ h_R \text{ and } h_s \text{ in metres} \quad . \quad . \quad . \quad . \quad (2)$$

Maximum potential V_{max}, and number of sparks per second N being chosen, the former according to insulating conditions, and a value being assumed for the decrement per semi-period, the antenna capacity is:

$$C\ (\text{mfds.})=\frac{I_s\ (\text{amp.})\cdot 10^6}{V_{R.M.S.}\ (\text{volts})\cdot\omega}=\frac{I_s\ (\text{amp.})\cdot\lambda\ (\text{metres})}{600\cdot\pi\cdot V_{max}\ (\text{volts})}\cdot\sqrt{\frac{24\cdot 10^8\cdot\delta}{N e^{\delta}\lambda\ (\text{metres})}} \quad (3)$$

Nomogram Fig. 4 gives factor $\sqrt{\frac{N e^{\delta}\lambda\ (\text{metres})}{24\cdot 10^8\cdot\delta}}$.

Mean potential $V_{R.M.S.}$ and maximum sending current can be calculated by aid of the same nomogram. Its use is as follows:

Join by a straight line (Fig. 3) value of λ (λ scale) to value of N (N scale). Draw a straight line from point where it meets D line to value of log-decrement δ per semi-period (δ scale).

Read at junction with the proper scale value of $\frac{I_{R.M.S.}}{I_{max}}$ or of $\frac{V_{R.M.S.}}{V_{max}}$

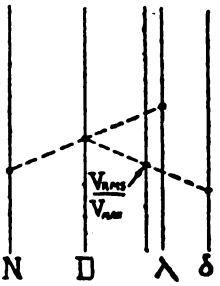

FIG. 3.

Power in sending antenna is:

$$P=\frac{N\cdot C\ (\text{mfds.})\cdot V^2_{R.M.S.}\ (\text{volts})}{2\cdot 10^9}\ \text{kilowatts} \quad . \quad . \quad . \quad (4)$$

Dimensions of antennæ may be calculated by Professor Howe's method.* Nomogram (Fig. 6) will shorten such calculations, especially when interpolation is necessary, and for solving reciprocal problems. Since it is not quite so simple as the preceding one, its construction will be described.

Professor Howe's formula may be written

$$C\ (\text{mfds.})=\frac{I}{4,145\cdot 10^6}\cdot\frac{\iota}{\log_{10}\left[\frac{l}{1,362\cdot d}\cdot\sqrt[n]{\frac{d}{r}}\cdot e^{-\frac{\beta}{n}}\right]}.$$

Let OA and O'A' (Fig. 5) be two parallel straight lines, and take $OM=\log\frac{d}{r}$.

Let P be the point of OO' such as $\frac{PO'}{PO}=\frac{a}{b}=\frac{1}{n}$.

Line MP meets $O'A'$ at M' and $\frac{O'M'}{OM}=\frac{a}{b}=\frac{1}{n}$.

Hence $$O'M'=\frac{1}{n}\log\frac{d}{r}=\log\sqrt[n]{\frac{d}{r}}.$$

* See THE WIRELESS WORLD, December 1914 and January 1915.

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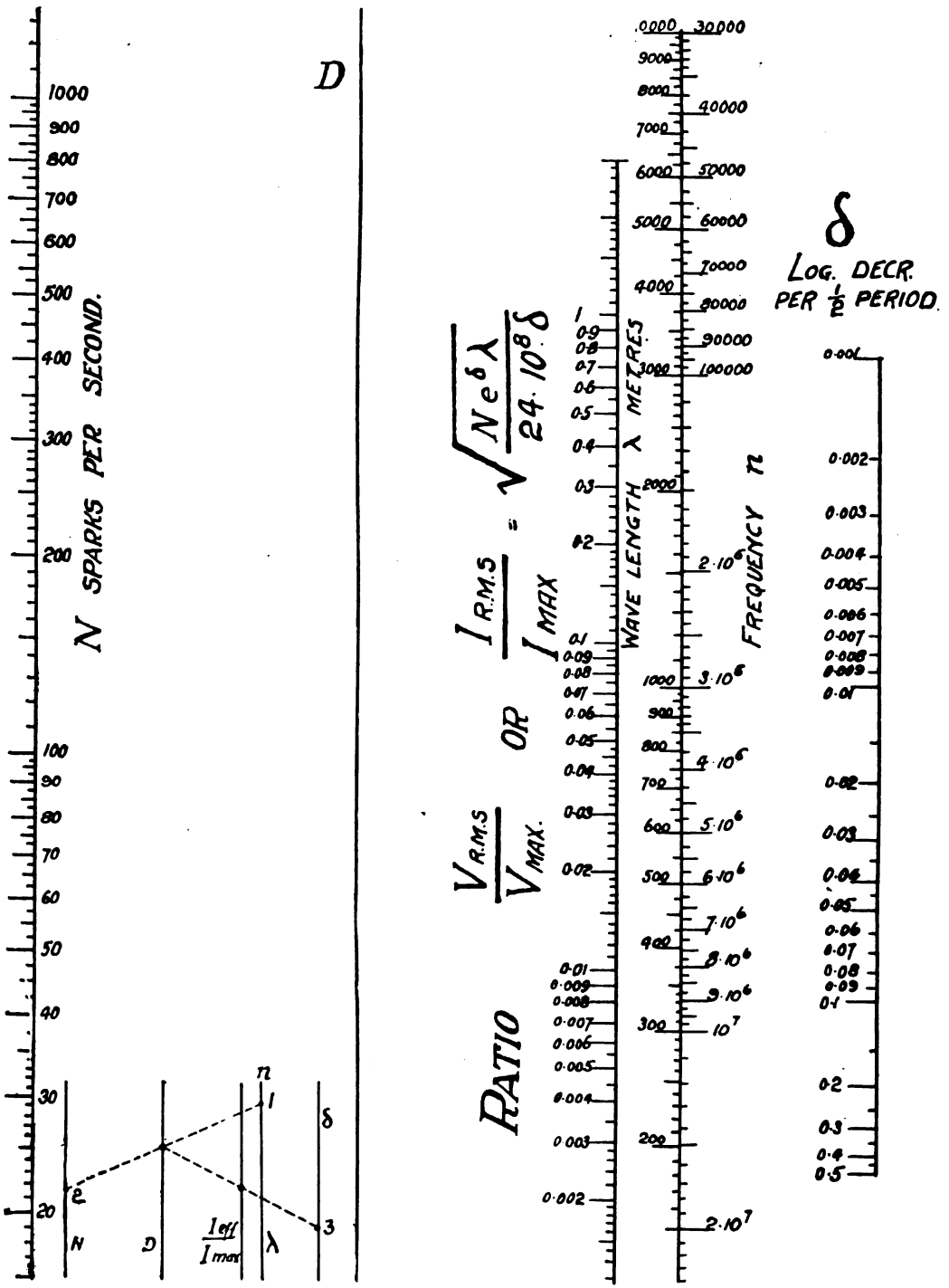

FIG. 4.

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Let PQ be parallel to OA, and take $PQ=\frac{b}{a+b}\cdot\log\frac{1}{1{,}362}\cdot e^{-\frac{B}{n}}$ and contrary to OM.

Lines OQ and MQ meet $O'A'$ at R and N respectively.

We have $$\frac{RN}{OM}=\frac{a}{b}=\frac{1}{n};\ \frac{PQ}{O'R}=\frac{b}{a+b}$$

$$O'N=O'R+RN=\frac{a+b}{b}\cdot PQ+\frac{OM}{n}=\log\left(\frac{1}{1{,}362}\cdot e^{-\frac{B}{n}}\cdot\sqrt[n]{\frac{d}{r}}\right).$$

Each value of n has a point Q [such as lengths $O'N$ equal to $\log\left(\frac{1}{1{,}362}\cdot e^{-\frac{B}{n}}\cdot\sqrt[n]{\frac{d}{r}}\right)$] and all having O' as origin.

Now let BC and DE be parallel to $O'A'$ and such as $BD=DO'$, and take $BS=\log\frac{l}{d}$. Line NS meets DE at T and $DT=\frac{1}{2}(O'N+BS)$

or $$DT=\frac{1}{2}\log\left[\frac{l}{1{,}362\cdot d}\cdot\sqrt[n]{\frac{d}{r}}\cdot e^{-\frac{B}{n}}\right]$$

and we shall have C (mfds.) $=\frac{1}{8{,}289}\cdot\frac{l\text{ (metres)}}{DT}$.

Draw FG parallel to DE and take $FU=\frac{l\text{ (metres)}}{8{,}289}$.

Line TU meets DF at V and we have $\frac{VF}{VD}=\frac{FU}{DT}=C$ mfds.

The capacities scale will be DF, and graduations will be points dividing DF in the ratio 0,0001, 0,0002, etc. . . . Thus this nomogram is used by joining by a straight line value of $\frac{d}{r}$ to value of n, afterwards joining point where it meets A line (see small fig. on nomogram, Fig. 6) to value of $\frac{l}{d}$; and finally joining point where this line meets B line to value of l. The result is read at meeting with C scale.

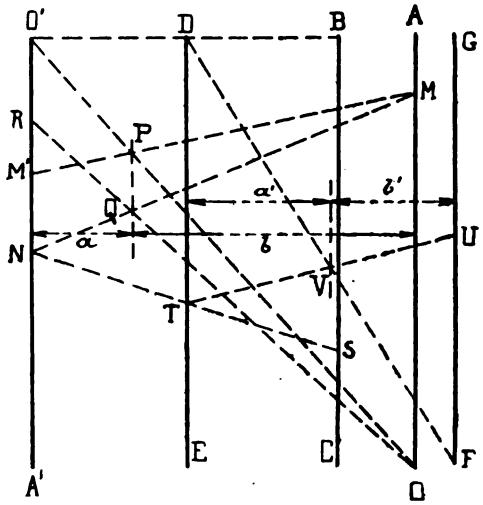

FIG. 5.

With regard to effect of earth, we have

$$\frac{1}{C'\text{ (mfds.)}}=\frac{1}{C\text{ (mfds.)}}-\frac{9{,}000\cdot E}{l\text{ (metres)}}\quad(5)$$

C' = capacity when accounting for effect of earth.

C = capacity when neglecting effect of earth.

E is given by Professor Howe's curve (WIRELESS WORLD, Vol. II., page 617).

(To be continued.)

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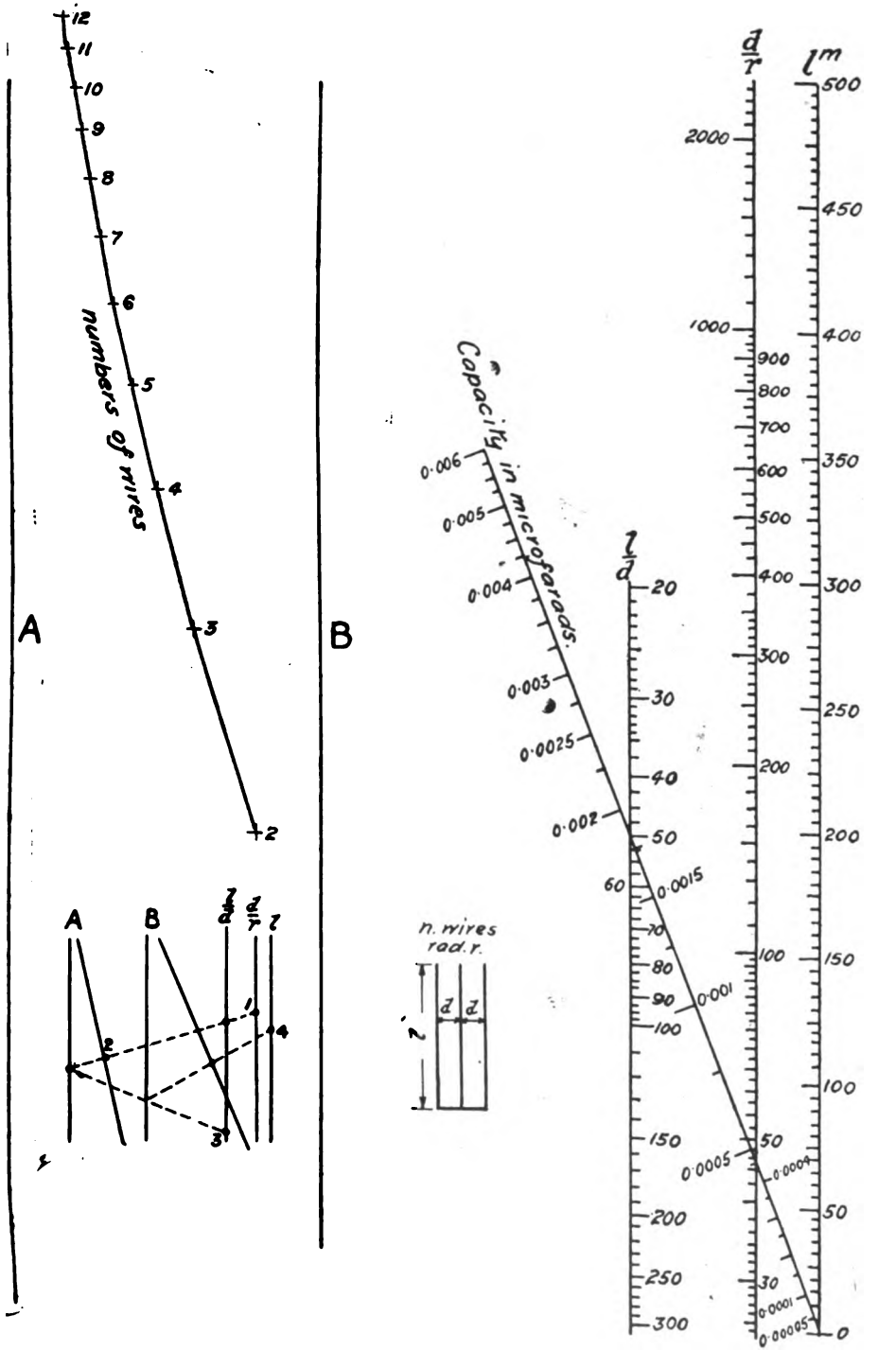

FIG. 6.

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Among the Operators

It is our sad duty, month by month, to record the deaths of the brave operators who have lost their lives at sea by enemy action and other causes in the wireless service of their country. Owing to the necessity of preventing information reaching the enemy, the names of ships and localities of action cannot be published, and in view of the fact that but few particulars are available of these actions full tribute cannot be paid to many gallant deeds. In one case this month, however, we are enabled to record a voluntary act of self-sacrifice and devotion to duty, which ranks with the highest it is possible to imagine.

Both for our own part, and on behalf of our numerous readers, we extend to the parents and relatives of these young men who so nobly uphold the "wireless tradition" the deepest sympathy in their bereavement.

* * * * * *

Roll of Honour.

The case referred to above is that of Mr. Eric William Gardiner, who was in his nineteenth year, and born at Edinburgh. Educated at the Royal High Street School, Edinburgh, and at Allan Glens College, Glasgow, he was, previous to his training at the North British Wireless Schools, Ltd., Edinburgh, employed as Customs clerk at Messrs. R. S. Waddell & Co., of Glasgow. After gaining his P.M.G. certificate Mr. Gardiner joined the Marconi Company in February of last year. Appended is the story of his heroism.

On the night of November 7th, 1917, the s.s. —— sailed from Europe on her way to the United States. At 8.30 on the following morning, when about 140 miles off the coast, the ship was attacked by a submarine, which launched a torpedo at her. Fortunately the torpedo passed under the ship without doing any damage. At this particular time Mr. Gardiner was in the wireless cabin sending out the distress call. A short time later the submarine appeared on the surface at a distance of about four miles, and commenced shelling the ship.

This shelling continued for about one hour, during which time Mr. Gardiner had got in touch with a shore station, and had been promised immediate assistance from a British destroyer. During the whole of the first hour's shelling he sat in his cabin, at his instrument,

OPR. ERIC WILLIAM GARDINER.

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keeping in touch in case of getting nearer assistance. About 9.30 a.m. the captain sent a message by the first mate to say that now he had got the offer of assistance he thought it advisable that Mr. Gardiner ought to leave the exposed position of the wireless cabin and take shelter.

Mr. Gardiner's reply to the first mate was that he had just got in touch with an American light cruiser, which he believed was nearer than the British destroyer, and likely to give earlier assistance. On these grounds he refused to leave the wireless cabin, saying that as soon as he got the full message through from the American cruiser he would take cover. The mate then left the cabin to report to the captain, and two minutes later the submarine, having abandoned solid shell for shrapnel, fired a shot which passed directly through the wireless cabin, decapitating Mr. Gardiner, and bursting on the roof of the engine room.

When the captain and officers went to the wireless room to see what had happened, they found his headless body still sitting in his chair, with the completed message of the American cruiser in front of him. (This actual message is still in the captain's possession.) As things turned out, the submarine continued to shell the ship with shrapnel, causing a great deal of damage, and although the gun crew on the ship put up a very brave fight, had it not been for the timely arrival of the American cruiser in all likelihood the ship would have been sunk.

The outstanding feature is the fact that, whereas Mr. Gardiner was offered release from his post, he refused because he thought he might get earlier assistance by remaining there. This proved to be the case, as the captain and officers state that although he had already been promised assistance it is quite possible that this assistance might not have come in time. To use the words of the captain and officers, "The plucky action of the wireless operator in sticking to his post was undoubtedly the means of saving the ship and the lives of the officers and crew, numbering forty-five."

* * * * * *

OPR. J. JENKINS.

Mr. John Jenkins, who lost his life when his ship was torpedoed, was born in Edinburgh on October 17th, 1897, and educated at Renfrew, Airdrie, and Shotts. Trained at the North British Wireless Schools, Ltd., Glasgow, he qualified, and after receiving the P.M.G. certificate was appointed to the Marconi Company's staff in June, 1917.

OPR. R. Y. BURRY.

* * * * * *

Born at Alyth, Perthshire, in August, 1900, Mr. Robert Young Burry was educated at Harris Academy, Dundee. After leaving school he took up farming, being employed at Auchterhouse, and at Ardgath Lundie, by Dundee. Desiring to embrace wireless as a profession he entered the North British Wireless Schools,

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OPR. J. E. BRITTON.

Ltd., Dundee, where he gained the P.M.G. certificate, and received an appointment in the Marconi Company last July. The ship on which Mr. Burry was serving was sunk by torpedo, and he is amongst the missing.

* * * * * *

Mr. John Edwin Britton, another victim of the torpedo, was born at Walthamstow in 1895, and went to the Coopers' Company's school at Bow. Commencing his career with the Atlas Assurance Company, Cheapside, E.C., he subsequently attended the East London Wireless Telegraph College, and there gained the P.M.G. certificate. Mr. Britton's service with the Marconi Company dated from September 6th, 1914.

* * * * * *

OPR. T. E. WALMSLEY.

Of Lancashire birth, Mr. Tom Ernest Walmsley was 24¾ years old, and hailed from Blackburn. Receiving his education at the Highfield Council School, Darwen, and Darwen Technical School, he was first employed by Messrs. Farrer, Baynes, Taylor & Co., cotton weavers, of Darwen. Later, taking up wireless, his training was completed at the Manchester Wireless Telegraph Training College, where he gained the P.M.G. certificate. He was appointed to the Marconi Company's staff on October 10th, 1915. The ship to which Mr. Walmsley was attached was sunk by torpedo.

OPR. L. A. CATTLEY.

* * * * * *

Mr. Louis Allen Cattley, formerly a clerk in the Railway Audit Office, Londonderry, was born in that city on June 18th, 1899. He was educated at the First Derry National School and the Evening Technical College there. Entering Marconi House School for training in wireless telegraphy, he gained the P.M.G. certificate, and was placed on the staff on December 17th, 1916. Mr. Cattley went down with his ship when she was torpedoed.

* * * * * *

OPR. J. PICKERING.

"Missing" is written against the ship on which Mr. John Pickering sailed. Harwood, Lancashire, was his birthplace, and he was 20¼ years of age. Receiving his education at the Accrington Secondary Day School, Mr. Pickering was first employed by the Premier Mills Company, Ltd., Great Harwood, in a clerical capacity, but being anxious to serve as a wireless operator he went to the City School of Wireless Telegraphy, Manchester, for training. When in possession of the

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OPR. A. C. S. PEGGS.

P.M.G. certificate he was accepted by the Marconi Company and joined the operating staff on June 12th, 1917.

* * * * * *

Mr. Arthur Clifford Sydney Peggs, born at Little Ilford on June 28th, 1899, was drowned when his ship was sunk by torpedo. His education, begun at the Ursuline Convent School, Ilford Branch, was completed at Leigh Hall College, Leigh-on-Sea, after which he entered the service of Messrs. Furness, Withy & Co., Ltd., as a clerk. Like many others, the "wireless call" appealed to him, and he commenced training at the British School of Telegraphy, London. The P.M.G. certificate was earned, and on its bestowal he proceeded to sea in the service of the Marconi Company.

OPR. R. BAGGE.

* * * * * *

Drowned when his ship was torpedoed, Mr. Richard Bagge was born on October 18th, 1899, at Kinsale, and received his education at Macroom. Being greatly interested in wireless telegraphy he underwent training at the Irish School of Telegraphy, Cork, and there qualified for the P.M.G. certificate. Mr. Bagge received his appointment in the Marconi Company's service on February 6th, 1916.

OPR. J. McKEAN.

* * * * * *

Mr. James McKean, missing after the torpedoing of his ship, was born at Bonhill, Dumbarton, on June 5th, 1900, and educated at the Academy, Vale of Leven, Scotland. For some time after leaving school he was engaged on clerical work for the Dalmonach Printing Works, Alexandria, Scotland, leaving that situation to take up wireless. Trained at the North British Wireless Schools, Glasgow, Mr. McKean obtained his P.M.G. certificate, and was appointed to the Marconi Company's staff on September 11th last.

* * * * * *

Mr. Harold Worfolk, also missing after his ship was sunk by enemy action, was nearly nineteen, and born at York, where he received his education at the Priory Higher Grade School. After being employed for a time by Messrs. Leak & Thorp, Ltd., drapers, York, on leaving school; he decided to adopt wireless as his profession, and was trained at the North-Eastern School

OPR. H. WORFOLK.

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of Wireless, Leeds. After receiving his P.M.G. certificate he was given an appointment by the Marconi Company at the end of November, 1917.

* * * * * *

OPR. A. WILLIAMS.

At his father's house, Merlin Lodge, Carmarthen, the death occurred on February 12th, after a short illness, of Mr. Aled Williams, who was stricken with consumption.

Mr. Williams was born at Gaiman, Argentine Republic, on February 28th, 1897, where his parents at that time owned a farm. Coming to Wales with his family in 1912, he attended Merthyr Secondary School, and Old College School, Carmarthen. His wireless tuition was received at the South Wales Wireless Training College, Ltd., Cardiff, where he gained the P.M.G. certificate, entering the service of the Marconi Company on August 29th, 1915. Mr. Williams was beloved by all who knew him, and his intense desire was to recover good health so as to be able to return to duty and, if need be, lay down his life in its execution.

High-speed Wireless Transmission

A Few Notes regarding our Double-page Illustration

On pages 36–7 we publish the first of a series of large drawings illustrative of interesting wireless apparatus. The illustration of the Marconi apparatus for high-speed transmission largely explains itself, but the following notes will perhaps help to elucidate one or two points of difficulty.

First of all it should be realised that the problems connected with high-power apparatus such as that shown are quite different from those of smaller power plant. In a high-power station the signalling key has to break extremely heavy currents, and elaborate precautions have to be taken to prevent wastage of power in arcing, and to enable clear-cut signals to be made. The opening and closing of high-power circuits at the ordinary speeds of hand-sending is difficult enough, but when signalling has to be effected at a speed of 100 words or more per minute the difficulties are multiplied a hundredfold. The apparatus in our illustration works as follows:

Firstly, signals are punched in an ordinary Wheatstone tape, such as is used for Post Office working, the tape then being passed through a Wheatstone transmitter at the requisite speed, long and short signals being sent "to line." These long and short electric currents actuate a specially designed pneumatic engine, opening and closing air valves and releasing air under pressure provided by the air pump shown. Tubes from the pneumatic engine are led to the signalling keys which, as in the case of all other high-power Marconi apparatus, are placed in the high-tension circuit to avoid dangerous surges.

In a forthcoming issue we hope to publish a large drawing of one of these high-tension signalling keys.

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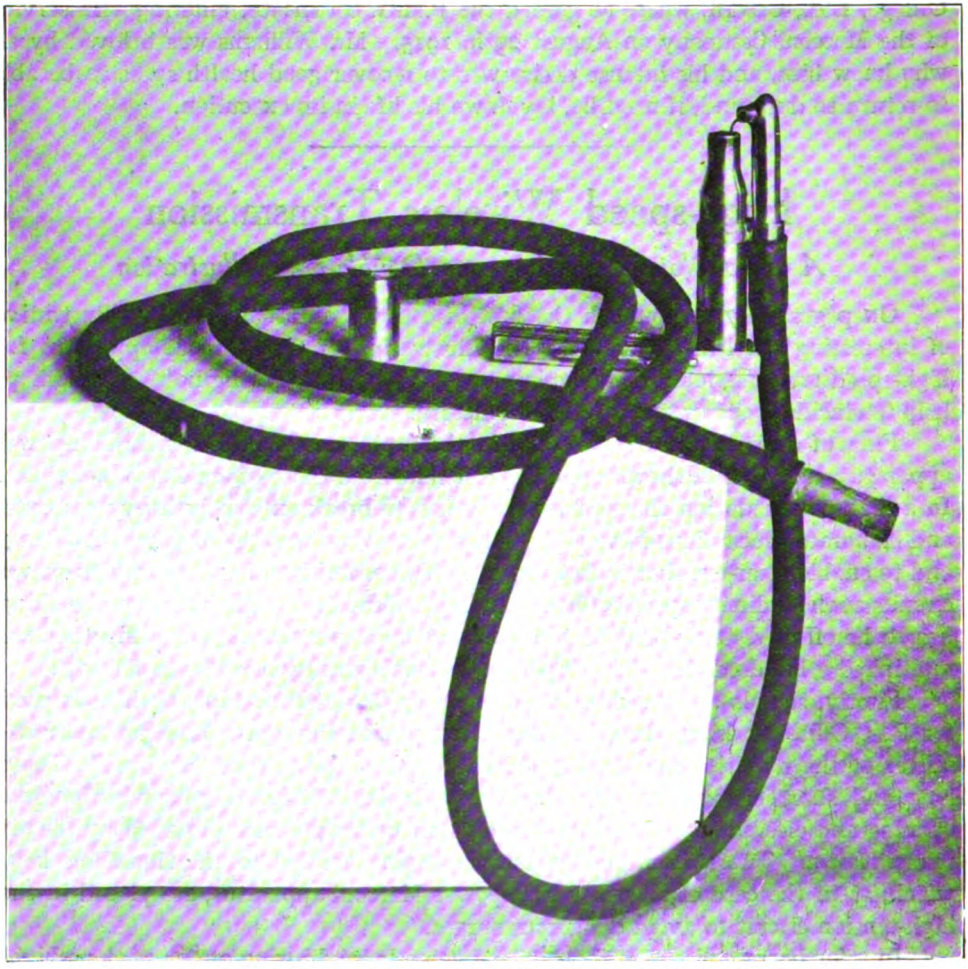
Improvised Tools

By W. E. SNOW

Most operators, at some time or other, experience small breakdowns, when, perhaps owing to lack of tools, they have to improvise something to repair the fault.

Usually it is a case of soldering, and where no blow-lamp is available, a lamp, giving a flame hot enough for most work, can easily be made from material at hand, thus saving what may be a serious delay.

All that is required is an ordinary ink bottle, with a small length of brass tube, or piece of tin rolled into the shape of a tube, inserted through the cork. The



BLOW LAMP MADE FROM CARTRIDGE CLIP AND CASE, ETC., AS DESCRIBED.

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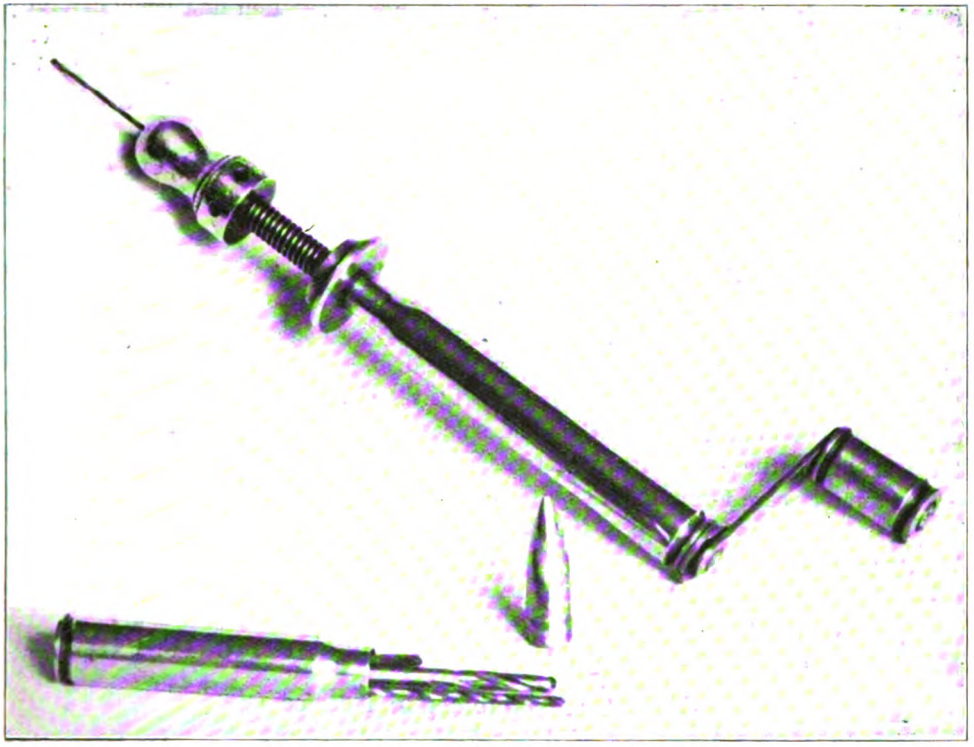

SMALL DRILL MADE FROM ODDS AND ENDS.

bottle is then filled with methylated spirits, the cork replaced, and cotton or substitute used as a wick.

Simpler still is the metal case containing the spare bradawl blades, just filled loosely with cotton waste soaked with spirits, which will hold enough to burn with a big flame for at least ten minutes.

A little thought will easily suggest other things which can be used for the same purpose.

The writer once used an empty cartridge case for a quick repair, and later, improving the idea, now possesses a novel little blow-lamp which has been used for sweating-on large size thimbles, as well as for the smallest work, giving an intense flame which will even *braze* small parts.

The following is a short description of how it was made.

A cartridge clip formed the stand or base, enabling the lamp to slide along in any position desired. The cap, or cover, was constructed from the large end of another case, cut off, and smoothed down to fit over the shoulder of the case forming the lamp.

The blowpipe itself was made from a bullet, the lead first being melted out, leaving the nickel shell, and an ordinary nipple fitted in the top, and silver soldered in.

A small brass spring clip holds the pipe to the lamp case, allowing it to slide

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up or down for adjustment. A rubber tube was next required, and this was obtained from a short length of 7-16ths covered wire, the fibre insulation first being carefully removed, then the wire withdrawn from the inside, leaving a tube of excellent rubber. The mouthpiece completing the lamp is merely an ordinary cane cigarette holder, usually supplied in tins of cigarettes. Different sized tubes may be had from the various grades of wire and used for many purposes.

Cartridge cases may be used for making many useful things. Cut off about half an inch from the large end, they make excellent crystal cups, and may be used with a cartridge clip as a holder and slider.

The writer made a small drill from some of these cases and a few odds and ends, which has proved very useful in model work. A 6-inch wire nail was threaded for about 2½ inches at one end, and two slots cut at right angles downwards for about an inch, thus forming the four jaws to grip the drill. An odd piece of brass, drilled through and tapped, screws on this, and forms the chuck to lock the drill bit. Two cartridge cases were fitted together and soldered lengthways to form the body of the drill handle, the ends drilled to fit over the nail, a small strip of brass and the large end of another case forming the small handle for turning.

The drill takes morse bits from 1 16th of an inch to 1-64th of an inch, and has been used for all metals.

The Annual Report on the American Navy

Naval Communication Service

A RECENTLY published Annual Report on the American Navy makes interesting reading. Reference is made under the heading of "Naval Communication Service" to radio-telegraphy, and it is mentioned that an executive Order issued by the President on April 6th, 1917, directed the establishment to take over such radio stations within the jurisdiction of the United States as may be required for naval communication.

It is also directed that all radio stations not necessary to the Government of the United States for naval communications be closed. In the enforcement of this Order 53 commercial radio stations were taken into the naval communication service for naval purposes. A larger proportion of the stations taken over were formerly operated by the Marconi Wireless Telegraph Company of America, in connection with their ship and shore service for the Mercantile Marine, and also for service between fixed points, such as that between Japan and the territory of Hawaii, and the United States. It was found that a number of the stations operated by the commercial companies could not be made available for naval uses, on account of duplication of the work, and accordingly 28 commercial radio stations were closed. In addition to this number, thousands of small amateur radio stations were closed, as well as several stations for service between fixed points, for which landlines were available and suitable. At the present time no radio communication is permitted on United States territory—not including Alaska—except through stations operated by the Naval Department or by the War Department.

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Instructional Article

NEW SERIES (No. 1).

EDITORIAL NOTE.—Below we give the first of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

PHYSICS is that branch of science which is concerned with the study of inanimate matter, its physical properties, the energy associated with it, the physical changes it undergoes and the laws regulating those changes. This interpretation excludes Biology, which is the science of matter and energy under the influence of life, and Chemistry, which deals with the changes of matter in respect to its essential nature and properties. As, however, chemical changes are always accompanied by physical changes, physics and chemistry are so intricately connected that it is difficult to distinguish between them. Accepting as a rough distinction the definition given above, physics is sub-divided into sound, light, heat, magnetism and electricity. The following articles will deal with those parts of the subject which are considered to be of special utility and interest to the student of wireless telegraphy. Electricity and magnetism have received special attention in former articles.

General Survey of Physics.—The accompanying schemes are intended to give the student a comprehensive glimpse of the ground covered by physics. They are by no means exhaustive, but are sufficient to indicate the main heads under which scientists classify matter and its phenomena.

First of all there is the grand generalisation that in the universe there are for the physicist only two **real things,** matter and energy; when we come to discuss them it will be shown why the number is limited to two. Under the general heading of matter there appear its various sub-divisions.

(1) **Masses.**—This refers to material bodies, including gases and liquids, in the particular form and distribution in which they appear, as distinguished from the sum total of matter in the universe.

(2) **Molecules.**—These are the smallest particles into which matter can be divided without losing its original properties. A **simple molecule** is a molecule of an element. A **compound molecule** is one which contains more than one element—*e.g.*, copper sulphate, which is composed of copper, sulphur and oxygen. The number of kinds of simple molecules known at present is between 70 and 80; the number of compound molecules is almost infinite.

(3) **Elements.**—This refers to matter in which the molecules are all of the same kind. The elements are divided into **metals, non-metals** and a third class

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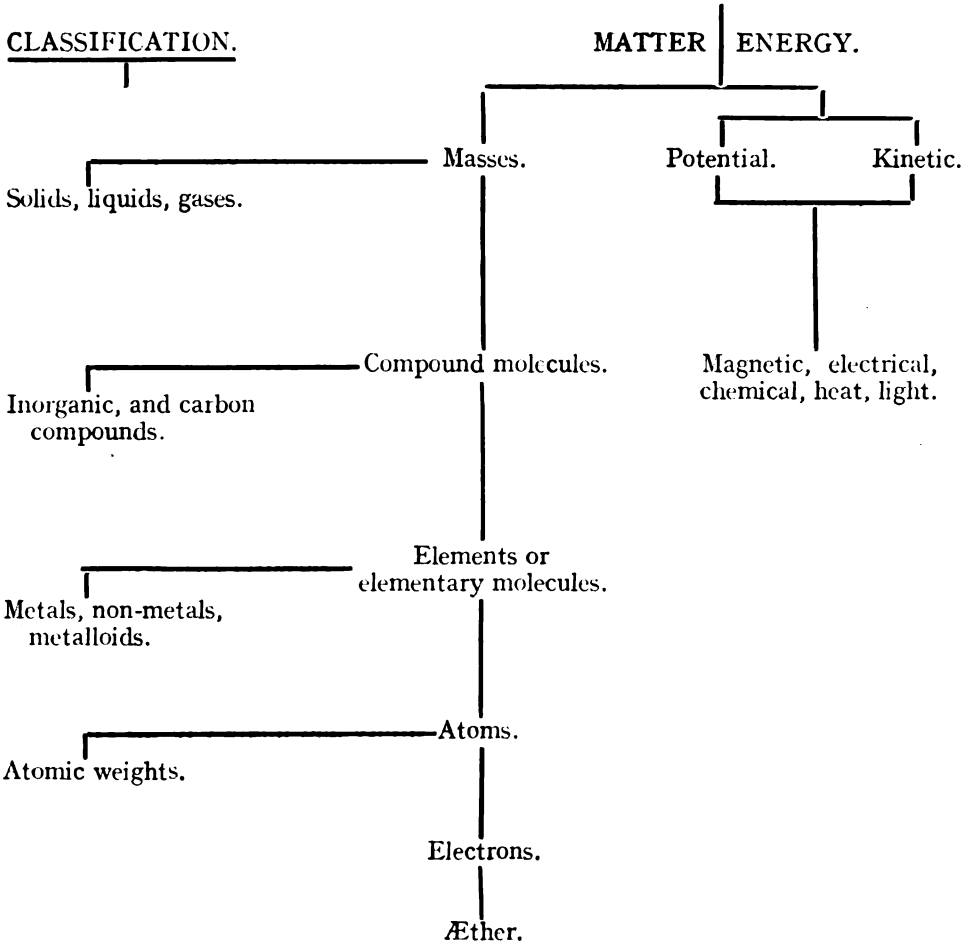
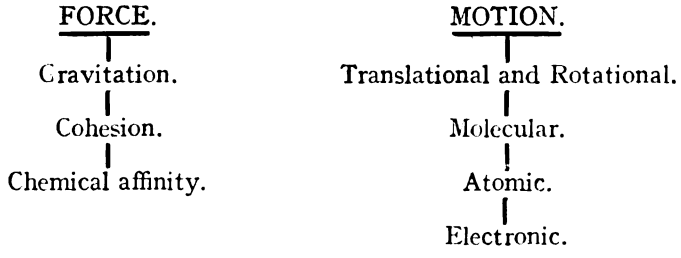


SCHEME 1.



SCHEME 2.

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containing those elements which in certain respects resemble metals and in others are akin to non-metals.

(4) **Atoms.**—These are the particles of matter of which molecules are built. They are defined as the smallest particles of matter which can take part in a chemical change and are conveniently classified by means of their weights as compared with that of the oxygen atom which is taken as 16.*

(5) Finally, atoms have been shown to be associated with smaller particles called **electrons.**

Under the heading of energy come its two main forms, **Kinetic Energy,** or the energy of motion, and **Potential Energy,** or the energy due to position ; energy of whatever kind can be classed under one or the other of these.

In the small scheme are roughly classified forces and the forms of motion. It may be noted here that **Gravitation** can be considered as attraction between masses, **Cohesion** as attraction between molecules, and **Chemical Affinity** as attraction between atoms.

These schemes are to be regarded merely as a synopsis, but should assist the student to sort out his ideas of the contents of the universe.

SPACE AND ÆTHER.

Matter may be broadly defined as that which occupies space, or which, to use everyday language, takes up room. Nothing else which is perceived by our senses can be similarly defined. Matter does not occupy the whole of space, which is conceived to be infinite, nor can any mass of matter occupy, at any given time, space occupied by any other mass. Those two statements hold good for our present purpose, although conclusions drawn from recent researches seem to contradict them.

There is, however, something which *does* occupy the whole of space, and which *does* occupy space filled by ordinary matter. This is the æther, which students of radiotelegraphy will recognise as being the medium in which electro-magnetic waves are propagated. **The conception of æther as a space-filling, elastic, imponderable medium possessing inertia is a highly essential part of the mental equipment of the student of Physics.** At present we need to fix our attention only upon the idea that it fills all space and that it therefore permeates all matter to such a degree that it may be conceived as filling up the spaces between the smallest known particles. As a net is moved through the sea in any direction and yet has its meshes filled with water all the time, so the densest material bodies can move in the universal ocean of æther without disturbing its uniform distribution in any way whatever. Ordinary matter cannot *grip* æther. The student may ask, " Yes, but what about the individual movements of the very smallest particles of matter? Do these disturb the æther? " The reply is that they do, but as this brings us abruptly to considerations in advance of our present subject we will leave the matter, having grasped the idea of the permeation by æther of all bodies, and turn to another very important conception.

The Three Dimensions.—There are three fundamental dimensions by means of which we can make measurements relative to space. In the case of a cube it is

* Formerly, their weights were compared with the weight of the hydrogen atom, which was taken as 1.

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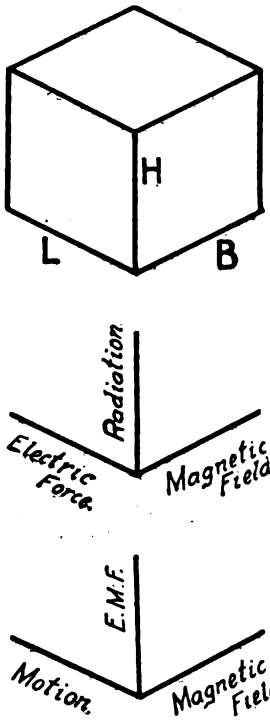
easily seen that all its measurements, apart from its length, breadth and height, are but functions of these. For instance, its volume is a function of S—that is, the length of a side, and is given by the equation $V=S^3$. Similarly its surface area is given by $A=6S^2$. Again, in the case of a rectangular prism the surface area is $2(LB+LH+BH)$, and its volume is $L\times B\times H$, where in each case L, B and H are respectively length, breadth and height. In all these examples our measurements are based on the three fundamental dimensions and for all similar operations we are necessarily so limited, for a fourth dimension is outside our experience.



FIGS. 1, 2 AND 3.

Fig. 1.—The lines L, B and H denote the length, breadth and height. Note that **they are at right angles to each other.***

Fig. 2.—The same three lines represent the directions of the electro-magnetic and the electro-static components of an æther wave and the direction of radiation. Note that **they are at right angles to each other.***

Fig. 3.—The same three lines represent the relative directions of a magnetic field, of the motion of a conductor cutting it at right angles, and of the resulting *EMF* in the conductor. **They are mutually at right angles.*** In this example the reader will recognise the principle of the dynamo.

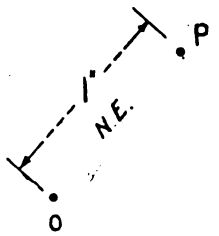


FIG. 4.

By this time it should be seen that the three dimensions of the æther and the distribution of electro-magnetic effects in them are matters of great importance to him who aspires to a true conception of the nature of æther-waves.

Position of a Point.—(1) *In a plane.*—The position of a point in one plane can be fixed by stating its distance and direction from some point of origin. Thus in Fig. 4 the point P is distant 1 inch from the point O, in a north-easterly direction. Its position can also be described by stating the length of a line joining O and P and the angle which OP makes with some other line, usually a horizontal line through O, the angle being measured in a positive (*i.e.*, counter-clockwise) direction.

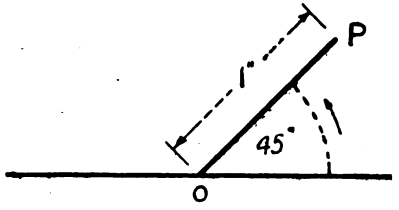


FIG. 5.

In Fig. 5 the position of P is $1_{45°}$, the unit of distance being the inch. If the unit chosen is $\frac{1}{8}$th of an inch the position of P is $8_{45°}$; if the unit be 1 foot we write $\frac{1}{12}{}_{45°}$.

* It is, of course, impossible to *draw* them at right angles to each other, but as they represent three converging edges of a cube, the reader will see that they *are actually* at right angles.

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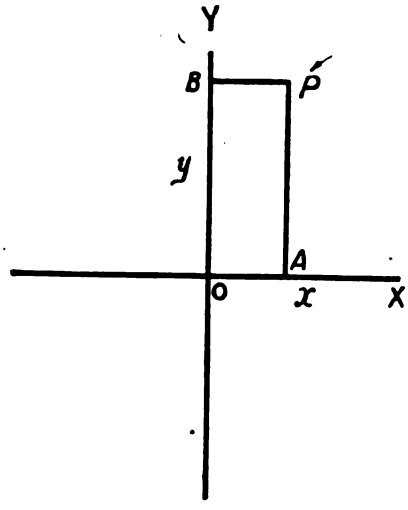

FIG. 6.

Another method of determining the position of a point in a plane is by finding its reference to its two **co-ordinates,** which are two lines at right angles to each other. In Fig. 6 the line OX is the **axis of x,** and OY the **axis of y.** A perpendicular is drawn from P to OX meeting OX at A, and another line perpendicular to OY is drawn from P to OY, meeting OY at B. OB is the **ordinate** of P, and OA its **abscissa.** Assuming the chosen unit of length to be $\frac{1}{10}$th of an inch, then P is "the point (4, 10)."

(2) *In space.* Space being three-dimensional the position of a point in it can be fixed by reference to three planes at right angles to each other. In Fig. 7 these planes are A, B and C. If the figure be supposed to represent a block fitted into the corner of a room it is easy to see that the two walls A and B, and the floor C, are three planes mutually at right angles. A corner of the block, the point P, is that the position of which is to be described.

PQ is the distance of the point P from the plane B (see fig.), PK its distance from the plane C, and PS its distance from the plane A. PS is called the **x co-ordinate** of P because it is parallel to the axis of x (OX), PK is the **z co-ordinate** and PQ the **y co-ordinate,** so that if the x, y and z *co-ordinates* of P are, say, 6, 4 and 3 respectively, measured each in the same units, the point P can be called "the point (6, 4, 3)."

Note that the point O lies in all three planes and that all its co-ordinates are zero.

Change in Position of a Point.—A change of position is called a **displacement,** to express which we must specify two things, its **magnitude** and **direction.** If a vessel starts from a buoy and travels in a straight line for 10 miles in a northerly direction the magnitude of the displacement is 10 (if expressed in miles), and the direction is N. A displacement is a **vector quantity** and can be represented by a straight line drawn to scale and in a certain direction. In the example just given we will take as our scale 10 miles to the inch. Fig. 8 then re-

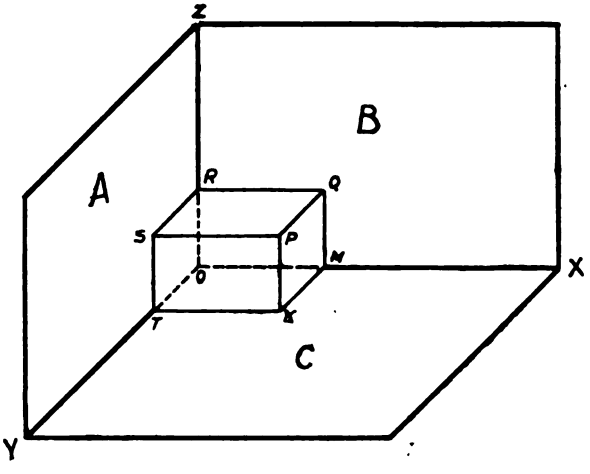

FIG. 7.

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presents the displacement undergone by the ship. Suppose the ship changes its course after reaching *B* and travels ten miles to the east, thus arriving at *C* in Fig. 9. It is obvious that, so far as its final position is concerned, it might as well have travelled directly from *A* to *C*. Thus the vector *AC* represents the resultant of the two displacements, and is equal to about 14 miles in an north-easterly direction. The process of finding this resultant is known as the **Addition of Vectors,** a subject with which the reader will deal more fully in his mathematical studies.

FIG. 8.

TIME.

The time element is one of the most important factors in innumerable questions relating to physics. Without due consideration of **duration** we could not express quantities such as velocity, acceleration or power, and, in fact, the whole system of physical units would collapse. Time being conceived as infinite, we have to refer it to a working unit based on some observable phenomenon which occurs at regular intervals. The daily rotation of the earth is such a phenomenon and the $_{86\frac{1}{400}}$th part of the mean solar day is the **mean solar second,** which is taken as the unit of time.

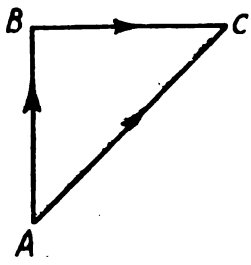

FIG. 9.

(To be continued.)

"Wireless World" and the Paper Shortage

A Serious Position

WITH the drastic curtailment of the imports of paper and raw materials and the rising cost of every item connected with the production of THE WIRELESS WORLD, we are compelled to raise the price of the magazine to 10d. per copy and the annual subscription rate to 12s. post free, commencing with the May issue. This price will, of course, be reduced immediately the present abnormal conditions cease, and meanwhile we trust that we shall continue to receive the wide support of which we are justly so proud. The present high standard of the magazine will be maintained, and all the regular features will appear as heretofore.

The position has also necessitated our revising the system which has been in force regarding the return by newsagents of unsold copies. Newsagents will be required to return to our publishers, not later than the 20th of the month of issue, all copies over-purchased commencing with this issue, and on their receipt credit will, of course, be given as usual. As our paper supply will be reduced, we shall have to "ration" the distribution of the magazine, and it is thus imperative that all readers who wish to receive the magazine regularly should place a standing order with their local newsagent, or send an annual subscription to this office. At the present time no magazine can afford to distribute large supplies on the off-chance that they may be sold to casual readers, and all who place a regular order will be playing their part in preventing waste during the present crisis.

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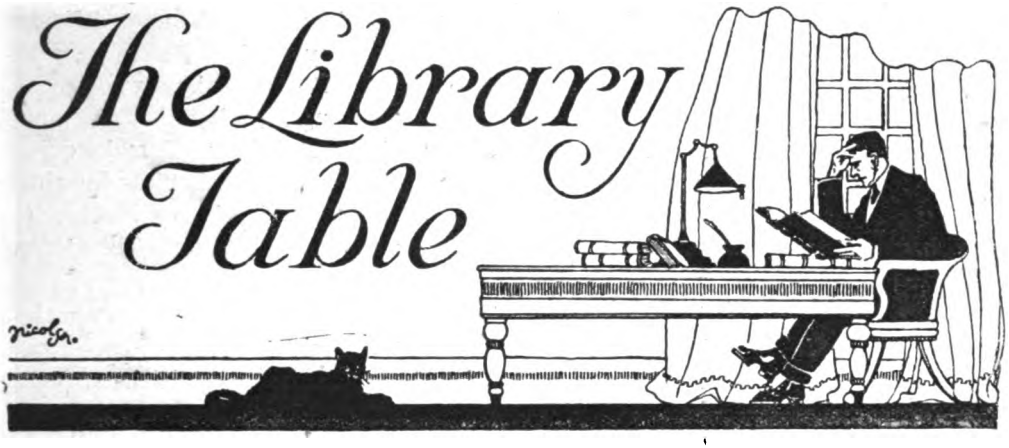
The Library Table



THE THEORETICAL PRINCIPLES OF WIRELESS TELEGRAPHY, WITH SEVERAL NEW HYPOTHESES FOR R.E.'S. By an I.R. 1918. *Published by Gee & Co. (Publishers), Ltd., 34 Moorgate Street, London, E.C.2. Price 6d.*

THERE have been very few examples of humorous books published on the subject of wireless telegraphy, although several books not intended to be funny have caused considerable amusement to experts. Of the consciously humorous variety, however, the example before us is by far the best we have seen.

On the first page of the book the author remarks that a preface seems to be necessary, if only to enable him to disclaim any responsibility for it. He felt the need of a book like this when he went through his course, as a kind of antidote, and determined that students should no longer suffer for lack of such a book.

Chapter I. deals in a light-hearted manner with the nature of electricity. Defining a conductor, the author says: "This is a substance through which electricity flows. If it does not flow through it, the conductor is an insulator, and must be treated accordingly." Not to be outdone by rival text-books, the writer adds to each chapter a series of questions to test the students' knowledge, such as (3) "Will a current flow uphill? If not, why not? Would it make any difference if there was a path up the hill?"

Chapter II., dealing with the nature and properties of alternating current, a somewhat difficult subject, is particularly illuminating. We cannot refrain from quoting paragraph 1 on Alternating Currents: "Alternating currents flow in opposite directions, but so quickly that it is difficult to know just where they are going. They therefore appear to be stationary (not stationery—a different thing altogether). They must therefore be considered in that light. When currents are obtained in this condition they are the cause of all the wireless phenomena at present known to science. . . . Oscillatory currents are even worse. You *cannot* tell which way they are going. Even scientists and professors cannot, so do not try, and let us assume they are going one way or the other; and this convenient hypothesis fully explains all the phenomena of ether waves with their static strain lines and magnetic fluxes. Magnetic flux . . . is of no use in soldering."

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The author then pursues his light-hearted career through all the most difficult branches of the science, giving formulæ where necessary (and unnecessary), and illustrating some of his worse examples by diagrams. Tilting at those who are so fond of mechanical analogies, he produces the following gem, relative to the properties of inductance and capacity. "A good mechanical analogy will make quite clear to the embryo student these two important properties of a circuit. Imagine a large steam engine of the marine type. The *fly-wheel* (the big heavy wheel with spokes that revolves round and round) would represent the *inductance*. The *spring* would represent the *capacity*."

Originally this little book was produced for private circulation among the author's friends, but it has proved so successful that a limited number of copies are available for the general public, and may be obtained from our publishers, price 7d., post free.

A DICTIONARY OF AIRCRAFT. By W. E. Dommett. London: The Electrical Press, Limited. 2s. net.

This useful little book should prove of service to the large section of the general public interested in aviation. The scope of the dictionary has been arranged to include popular as well as scientific and technical terms, also symbols and abbreviations used in aeronautical periodicals and text-books. As a whole the terms are clearly explained, although in some cases improvements might be made. Thus "camber" is defined as "the convexity or rise of a curve of an aerofoil from its chord usually expressed as the ratio of the maximum departure of the curve from the chord as a fraction thereof." This is not very illuminating to the non-technical man, and in any case there should be cross references to "aerofoil" and "chord," both of which terms are explained in their proper place.

The definition of "airplane" too, is not very satisfactory. It is said to be the "Anglicised form of 'aeroplane,' a term used by the Admiralty and *Daily Mail*." The word is largely used in the United States, which fact should certainly not be ignored.

We notice certain omissions which might be rectified in subsequent editions. For instance, although the "L.V.G." and "Fokker" machines are explained, we cannot find any reference to the Gotha or Albatros types—quite an inexcusable omission, seeing that the book is dated December, 1917.

The Purchase of Books for Readers

THE PUBLISHERS of THE WIRELESS WORLD are pleased, at all times, to obtain for readers any of the publications reviewed in these columns, as well as books on all technical subjects. Orders should be accompanied by a remittance covering the full cost of the book and postage. Should the amount forwarded exceed that required, the balance will be returned to the sender.

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Personal Notes

On February 11th last the Head Office Staff of the Associated Marconi Companies met together for the purpose of making a presentation to Mr. and Mrs. Godfrey Isaacs on the occasion of their silver wedding. The gift, which took the form of a handsome Georgian tea service in silver, was handed to Mr. Isaacs on behalf of the staff by Senatore G. Marconi, G.C.V.O., and Captain Sankey, R.E. In a short speech Captain Sankey said that the gift was a unanimous expression of the regard in which the staff held Mr. and Mrs. Isaacs, the former both as an employer and friend and the latter for her interest in the social activities and sports.

Senatore Marconi, who was not expected to be present, managed to find time among his multitudinous duties to attend the presentation, and in a moving speech

CAPTAIN SANKEY, R.E., HANDS THE GIFT TO MR. AND MRS. ISAACS.

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MARCONI HOUSE STAFF AT THE PRESENTATION.

spoke of his own kindly regard for Mr. Isaacs and said how pleased he was to be associated with the staff in their tribute. Mr. Isaacs in reply said that he was at a loss how to express his emotions on receiving such a splendid gift from the staff. During the time he had been associated with the Marconi Company he had learnt to hold in high esteem those who were working with him, and he thanked them most sincerely for this gift. Mrs. Isaacs followed with a happy little speech, and on Captain Sankey calling for three cheers for Mr. and Mrs. Isaacs these were given with a heartiness which could not be mistaken. The staff, feeling that three cheers were scarcely enough to celebrate the occasion, followed with three more just as hearty and the little ceremony terminated.

DOVER PATROL LOSSES.

From Dover we learn with regret of the death of Warrant Telegraphist Francis Gordon Linwood, who was killed in action with enemy destroyers on February 15th. Aged 30 years, he received his wireless training at the British School of Telegraphy, Clapham Road, and joined the staff of the Société Anonyme Internationale Télégraphie Sans Fil in 1910, subsequently serving on German, Dutch and Spanish vessels, as well as at the Cadiz Station and in the Brussels Office. He had left the Marconi Service prior to the war, but, although far from strong, he volunteered for naval service in November, 1914, serving first on an Admiralty collier with the

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WARRANT TELEGRAPHIST
F. G. LINWOOD, R.N.R.

Fleet during the Falklands Battle, afterwards on vessels of the Dover Patrol, where he had many times seen action with the enemy. He was buried at Teddington on February 22nd with full naval honours, a party of about 200 officers and men being in attendance. His loss is keenly felt by his fellow wireless officers of the Dover Patrol, with whom he was extremely popular.

Harold Fielding, a wireless operator on one of the mine-sweepers in the Dover Patrol, who was killed in action on February 15th, was the son of Mr. Ernest Fielding, of Hugh Oldham Drive, Lower Broughton, Manchester. In December, 1915, he enlisted in the R.N.V.R., and at the time of his death was in his 22nd year.

Wireless Operator Gilbert Lambert, R.N.V.R., formerly on the staff of the Folkestone Electricity Supply Co., Ltd., and Wireless Operator C. S. Harrison, a student at the Royal Technical Institute, Salford, were both killed in the enemy raid on the Dover Patrol of February 15th. All wireless men will join with us in expressing sympathy with the parents and relatives of these gallant young men.

Good Wishes.

Senior operators of the M.I.M.C. Co., Ltd., will be interested to read of the marriage of R. Jones, who was with the Company from 1910 until last summer, when he was transferred to the R.N.V.R.

The marriage took place in London early in February, the bride, formerly Miss Millicent Watson, of Brisbane, Queensland, returning with her husband to Scotland, Mr. Jones being stationed at one of the Admiralty stations there.

Killed in Action.

Members of the staff of Marconi's Wireless Telegraph Co., Ltd., will be sorry to hear of the death of Phillip Hugh Soorn, who was killed in action on February 2nd. Mr. Soorn, who prior to the war was engaged as a wireless operator at the Towyn wireless station, joined the forces on their mobilisation, rising to the position of staff sergeant. He was wounded during a bombing raid and never regained consciousness, passing away after a few hours. He was held in high esteem by all with whom he was associated, and we take this opportunity of expressing our sympathy with this gallant soldier's parents in their grief.

STAFF-SERGT. P. H. SOORN, R.E.

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POSTHUMOUS AWARD.

Among the recipients of war honours at a distribution at Leeds recently was Mrs. Bradley, who received the D.S.M. awarded to her son, Walter Edwin Bradley, Chief Petty Officer (2nd grade), R.N.A.S., who was killed in a seaplane on December 10th, 1916. Mr. Bradley was engaged at the wireless station of Las Palmas from 1912 to 1914 and afterwards entered the R.N.A.S. in the wireless section. Mr. Bradley was very popular in the Marconi Service, and the senior men who will remember him in pre-war days will be proud of the recognition accorded to their colleague.

MILITARY APPOINTMENTS.

The following have been appointed Acting Captains in No. 3 Wireless Signal Squadron of the Indian Army :—Lieut. F. J. Foxlee (Indian Army Reserve of Officers), Lieut. B. M. Peek (Hampshire Regiment), Sec.-Lieut. R. A. E. Blake (Hampshire Regiment), Sec.-Lieut. B. Mead (Hampshire Regiment).

MISS F. K. WEST.

MISSING.

We learn from the *Bury Guardian* that Clarence Richardson, wireless operator, R.N.V.R., was on a boat sunk recently. He has since been missing, and in the circumstances it is feared that he has been drowned. Richardson, prior to joining the wireless service, was a railway goods clerk. He was 18, and was a patrol leader in the 14th Bury Troop of Boy Scouts. His father, Private William Richardson, was killed in September last.

WOMEN'S SERVICE.

The accompanying photograph shows Miss F. K. West, a recent recruit to the W.A.A.C. from the staff of Marconi's Wireless Telegraph Company, Limited. Miss West is the third of this Company's staff to join the forces.

A WELL EARNED AWARD.

We are glad to announce the award to Air Mechanic J. H. Holdershaw, R.F.C., of the Distinguished Conduct Medal. Holdershaw, who stuck to his wireless post in the face of violent attack, had his aerial blown to pieces nine times in one day.

MENTIONED IN DISPATCHES.

In the *London Gazette* for March 7th the following wireless men are mentioned in dispatches :—Second Lieutenant J. A. Cooper, Lance-Corporal A. C. Diver, Sergeant G. S. Little and Sergeant A. Porteous, all of the wireless section of the Royal Engineers attached to the East African Forces.

DEATH OF A WELL KNOWN OFFICIAL.

We regret to announce the death of Commander A. Houghton, R.N.R., President of the Mercantile Marine Service Association. Commander Houghton, who had been suffering from ill-health for some time, made his last appearance in public on November 20th, presiding over a meeting of the Council of the Association.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly.* (3) *Queries should be as clear and concise as possible.* (4) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers.* (5) *The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

C. C. G. (Musselburgh).—(1) Your first question is of a constructional nature and therefore cannot be answered during the war. (2) The effect you mention is one of many to be obtained with sensitive receivers. If you will carefully examine the chart of connections, you will see that there is a capacity path to earth through the crystal if connected in the way you mention. Signals so received are, of course, untuned.

AMPLIFIER (Newport Pagnell).—The address you ask for is Marconi's Wireless Telegraph Company of Canada, Ltd., Shaughnessy Building, 137, McGill Street, Montreal.

E. C. (Kingston-on-Thames).—In the event of an operator losing his effects at sea as the result of enemy action, compensation may be paid by the Board of Trade up to a maximum of £50. Application must be made to a Board of Trade Shipping Office for a claim form. This insurance costs the operator nothing.

H. W. L. (Rotherhithe).—(1) Each circuit of the receiver (and this includes the aerial) must be tuned to the particular wave-length it is desired to receive, unless the station from which signals are being received is fairly close, when with tight coupling oscillations may be forced upon the receiver irrespective of its tuning. (2) Inductance is in centimetres. (3) Whether an L or T aerial is erected on board ship depends usually upon the position of the cabin and the convenience of arrangements. For a given length of wire the L aerial has greater inductance as the inductances of the two arms of the T aerial are in parallel. An L aerial with a long top is directional both for transmitting and receiving, signals coming in strongest from the direction away from the free end. Unless, however, the top of the L aerial is long in relation to the down lead this effect is not very noticeable.

BOB (Stroud Green).—(1) At the present time there are no publications devoted entirely to Continuous Wave Telegraphy. The Wireless Press, Ltd., will shortly issue a volume devoted exclusively to the subject, and an announcement will appear in our pages in due course. (2) Normally the age limit of the Marconi Company is 25, but at the present time, owing to the requirements of the Military Service Act, men are not accepted above the age of 18 years unless, of course, they are ineligible for the Army. Such a man with the qualifications you mention would probably be accepted immediately by the Company, provided he passed the Company's doctor. His training would then be completed in the Marconi Company's own school. Application should be made to the Traffic Manager, The Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C.2.

G. T. S. (Hounslow).—(1) The doctor's fee for the medical examination of the Marconi Company's students is 10s. 6d. It is necessary that applicants should be tested by one of the Company's own doctors. (2) A mess suit is not essential to an operator's outfit. With regard to the second part of your question, we would refer you to the notes on this subject which appeared in March, and would suggest that you consult your local tailor.

W. D. (Beeston).—Both the purchase and possession of wireless apparatus are prohibited to amateurs at the present time, and therefore you would not be permitted to purchase the set to which you refer. We would advise you to spend your spare time in studying the theory of wireless telegraphy in preparation for the time when amateur experimentation is again permitted.

E. N. S. (Blackpool).—(1) The vacancies in the Marconi Company's service are for men to go to sea as wireless telegraphists. In practically all cases appointments to land stations are given after some years of service on board ship. (2) *The Elementary Principles of Wireless Telegraphy* is a more suitable book. Please see Rule 5 at the head of this section

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A. G. B. (s.s ——).—(1) We have heard of several cases similar to that you describe, on ships wired on the two-wire system without an earth return, and the trouble is usually due to a leakage to earth from the dynamo. Sometimes, too, there is a leakage from one of the lampholders. From the fact that there is one noise per revolution of the dynamo we should think that there is a "flat" on the commutator, which gives a little sparking, although not sufficient to show on inspection. (2) We are always pleased to consider articles for publication to be paid for at our standard rates. Many thanks for the cutting attached to your letter, which is very interesting.

B. W. F. (Leeds) does not send his full name as stipulated in our rule No. 6. On the receipt of this we will give him the information he desires.

L. A. (Ipswich).—There are wireless sections connected with the Royal Flying Corps and the Royal Engineers, for both of which the men are trained by the Army authorities. You should apply to the local recruiting office for particulars of how to join these sections, and as you are not yet 18, it will, of course, be possible for you to volunteer for such work.

L. H. (Tod).—We would advise you not to attempt to construct the apparatus you mention, as it would be difficult to prove that it was not intended for wireless work.

"NAVIGATION" (London).—You do not say whether the appointment you desire is in the naval service or on the staff of a commercial company. Coast station appointments in the naval service are usually made from the ranks of experienced naval radiotelegraphists, and it is highly improbable that such appointments could be gained by a new recruit to the service. The Marconi Company's land stations in Great Britain are at present being used for Government work, and, in any case, positions in them are reserved for experienced men.

D. O. G. (Ashton-under-Lyne). — Coast station appointments, as mentioned above, are reserved for experienced men, and, in view of your age, we do not think that you would be able to qualify for an appointment as a wireless engineer.

A. B. (B.E.F.) sends no name on his query, and it therefore cannot be answered.

W/T (B.E.F.), who has practical experience with wireless apparatus with the Forces, wishes to know whether he can sit for the Postmaster-General's Examination by taking a correspondence course. *Answer*: A good correspondence course can teach our correspondent sufficient theory to pass the theoretical side of the examination, and if he can send and receive not less than twenty words a minute he should be able to pass the telegraphic side. The Postmaster-General's Certificate certifies that the operator "is able to adjust the apparatus ordinarily used in some well-known system of wireless telegraphy, so as to suit the varying conditions of working, without using excessive transmitting power, and has an efficient working knowledge of the regulations applicable to the exchange of radiotelegraphic traffic." From this our correspondent will be able to judge whether he has sufficient knowledge to pass the practical side. With regard to question 3 in our correspondent's letter, asking whether in the event of his obtaining a First-Class Postmaster-General's Certificate he would have a chance of success in the Marconi service, we can, of course, offer no opinion, as no one knows what the conditions will be on the termination of hostilities.

"A MECHANIC" (Edinburgh).—The fact that you do not possess the Postmaster-General's Certificate would prevent you obtaining employment as a seagoing wireless operator. Without any more particulars regarding your other qualifications we cannot pass any opinion upon your prospects of obtaining other wireless employment.

A. O. C. L. (Grantham).—You are quite correct in your statement, and we must thank you for bringing the error to our notice. It is strange that it has never been remarked before.

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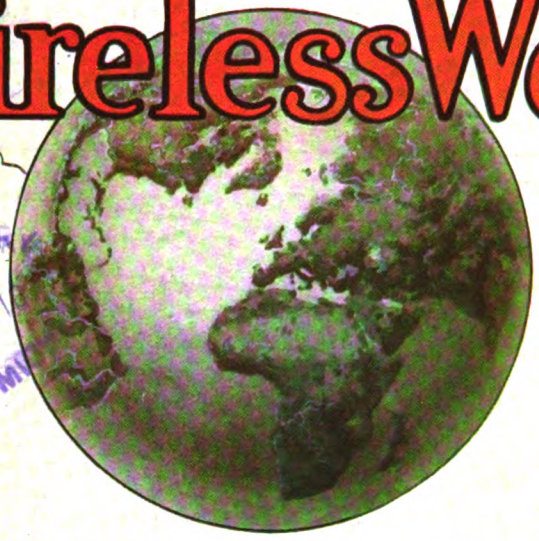

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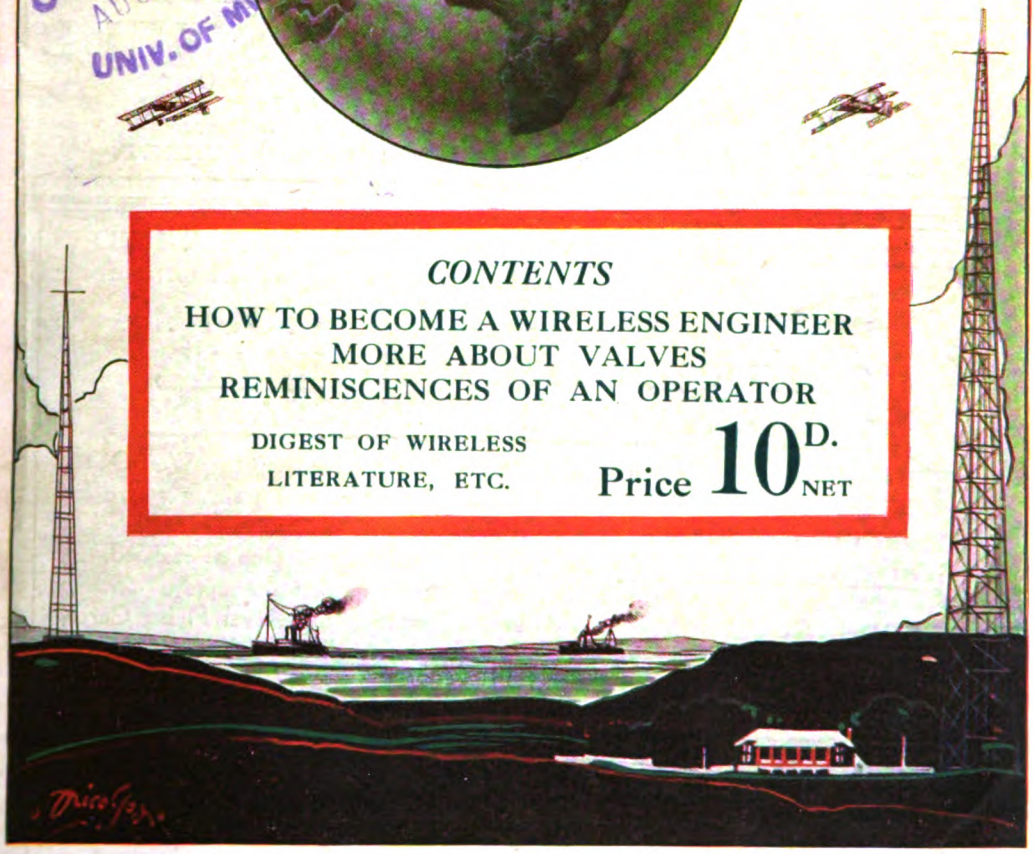

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The
WIRELESS
· WORLD ·

Volume VI. No. 62. MAY, 1918.

Reminiscences of an Operator

By W. D. OWEN

How the Skipper was Converted

FROM the very beginning the skipper made it perfectly plain to me that he resented the introduction of wireless telegraphy on his boat. Had he not spent forty years of his life on ships without it, and never been inconvenienced by its absence? Had he not sailed the Seven Seas and helped to make Britain's prestige what it was before wireless was invented? He considered it "darned impertinence" on the part of foreign Governments to "require apparatus and operators for radio communication" on British vessels that honoured their seaports by calling at them. Moreover he strongly objected to having a "passenger" on his articles for the sake of a few paltry signals, when all his officers were skilled in the use of flags, Morse-lamp, semaphore, and so on *ad nauseam*.

It may have been due to the latent conservatism of a sailor past middle age, or perhaps it was just a case of mental inertia, but the fact remained—I and my gear were not wanted. This, of course, was before the *Titanic* disaster had wiped out all such prejudices and demonstrated the advantages of wireless telegraphy

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beyond all possibility of dispute. In pre-*Titanic* days shipowners were inclined to regard wireless as an unproductive expense, and skippers looked upon it with suspicion because it was probably the one thing on board that they knew nothing of. But Uncle Sam's laws must be obeyed by those who use his ports, particularly when $5,000 is the penalty for default. So, as the lesser of two evils, I was permitted to remain.

The officers took their cue from the skipper and froze me out. The engineers might have taken kindly to me but for the fact that I used their "juice" and could demand to have the dynamo started up if required for wireless purposes. The idea of generating electricity for some other bounder to use was all the more distasteful because the bounder in question did not know the difference between a thrust-block and a spragging-iron, but probably knew more about their own dynamos than they did themselves.

So by the time we got round to "Gib" I was heartily sick of my own company, and would have kissed the bo'sun's mate if he'd spoken a kind word, but even he regarded me as "one of the blinking gold-lace brigade."

I amused myself by watching the scenery when there was any, and, failing that, by hanging over the bows and watching the flying-fish dispersing in all directions.

Driven to the seclusion of my cabin one day by a sharp shower, I found a decrepit copy of Haeckel's "Riddle of the Universe" stuffed into a ventilator to keep the draught out. The fact that I essayed to read it, and eventually got quite interested, indicates the state of my mind at the time. I must confess that I skipped "embryonic development," "psychic gradations," and "phylogeny of the soul," and had struck some really clever stuff about matter and ether. In my circumstances no wireless enthusiast would have resisted these pages.

While thus engaged I had my first visitor. It was the purser. He was a kindly soul, but there were other reasons for his visit, as I found out later. After a few banal generalities he picked up Haeckel and was visibly impressed. I poured silent blessings on to the head of the unknown owner of the book for the kudos he had bequeathed to me. I rather fancy that Haeckel saved me from certain vague unexpressed duties relating to the tallying of cargo and the copying of manifests. However, he told me in casual conversation as it were that the old man shied every time I got into his line of vision, and had said to him only that morning: "Can't you find that wireless chap something to do?"

Following up my advantage, I generously offered to "help him out" if he found himself "up against it," well knowing that he'd sooner die of overwork than ask me for help after that.

The s.s. *Neuralgic* was a pretty big cargo boat built on modern lines, with accommodation for a few passengers, who dined with the captain and officers in the saloon. Conversation was always brisk at the table, and covered every subject under the sun. So far they had totally ignored my presence, and did their talking past me, over me, and through me—a proceeding that interested me immensely, for it gave me the opportunity of discovering that the average man is a poor debater. My first few days at sea taught me that, although a few voyages might broaden a man's mind, a lifetime of it has just the opposite effect.

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TYPHOON BAY, HONG KONG—THE CHINESE JUNKS' AND SAMPANS' REFUGE WHEN TYPHOON WARNING SIGNALS ARE DISPLAYED.

I was not at the captain's table, in fact I had my back to him, but his voice dominated the table talk. Curiously enough, wireless telegraphy was frequently mentioned one way and another, but I was not a party to these discussions, until one day the question of automatic calling-up apparatus was raised. A passenger had the temerity to question a statement to the effect that the wireless gear was useless unless "someone was glued to it all the time," and for the first time I was appealed to. Consciously or unconsciously the skipper had so worded his question as to constitute what was virtually an invitation to dig my own grave. "Suppose," said he, "the *Rheumatic* was within range and sent out distress signals in the middle of the night when you were in your bunk, would that box of tricks of yours enable me to render service?"

Momentarily I was nonplussed by the form of the question, and answered meekly enough that it would not. "What did I tell you?" he said, turning to the passenger. "It's just a fad, and nobody realises its limitations better than those who operate it."

"Excuse me, sir," I said, butting in, "but you based your argument on a supposition. Allow me to suppose that I was not in my bunk at the time, but was on duty, and the chances are in my favour, for I am never in my bunk more than seven hours out of the twenty-four; the story would have a very different ending, would it not?"

"Oh, I'm not saying it's altogether useless," he replied; "my contention is that its limitations are greatest in just those directions which offer the largest sphere of usefulness."

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"But we haven't reached the zenith yet," I pointed out. "The story of wireless telegraphy is still in its opening chapters, and even now I make bold to say that there's not a single thing that you can do with your flags, semaphore, Morse-lamp and rockets that I can't do infinitely better with the wireless gear. The limitations to which you refer apply to your own signalling devices to at least the same extent, and I doubt if you'd care to sail without them."

The skipper seemed tickled by my spirited defence, and was by no means annoyed at being bested in argument; he merely said as a parting shot while folding up the serviette, "Very well, it's up to you to show us what you can do."

Some weeks afterwards I found that we had arrived in the typhoon region, and naturally the conversation frequently drifted to this topic. I heard many tall stories of the violence of these cyclonic storms peculiar to this part of the globe, and was firmly convinced that my leg was being pulled. So I remarked that I'd very much like to experience one, as it would give me something to write home about. The abuse I suffered convinced me that they were in earnest, and the typhoon as a topic of conversation was thereupon dropped.

The weather was champion, and we left Manila behind us, spent a few days in Hong Kong, and then headed for Kobé. I found Kobé a delightful place, and did not share the skipper's anxiety to get away, but the "autocrat of the saloon table" had his own way, and we were soon at sea again. Meanwhile a breeze had sprung up—a nasty jerky breeze that would almost take a door off its hinges one moment and fizzle out just as suddenly the next. The sea, too, had a peculiar motion, and the atmosphere was oppressive. These things were of no significance to me at the time, for this was my first voyage.

There was little wireless traffic about at the time. A Japanese station was busy with its monstrous code, and some U.S. Revenue cutters up north were exchanging signals. One of them made reference to a typhoon, and gave us some meteorological data, but it was addressed specifically to a certain ship, and it did not occur to me to mention the matter to the skipper. So, for a change of scenery, I went up on deck.

By this time the sea was running pretty high, and the horizon seemed perfectly inebriated. I found much interest in watching Dame Nature in a threatening mood, but I did not expect to see her lose her temper as she did. The motion of the ship became more and more accentuated, and the bo'sun got his men busy shifting all the loose tackle before any got lost overboard. And then the wind came! It howled and whistled and shrieked. At times the roar was like a prolonged explosion. Usually our boat had a slow roll, but she had now become quite frisky. Great waves broke over us and swished about from side to side. The weight of them was enormous; one of the port lifeboats crumpled up like matchwood. Every man on the ship got busy shifting or lashing down movables. We rolled about like skittles. One got his arm broken.

The captain ordered the bows to be brought round to the wind and rang down for half speed. Everybody was busy for a while—the officers in their respective departments, the engineers preparing for a busy night, crew battening down hatches, lashing tackle, etc., and the passengers all busy with urgent private affairs.

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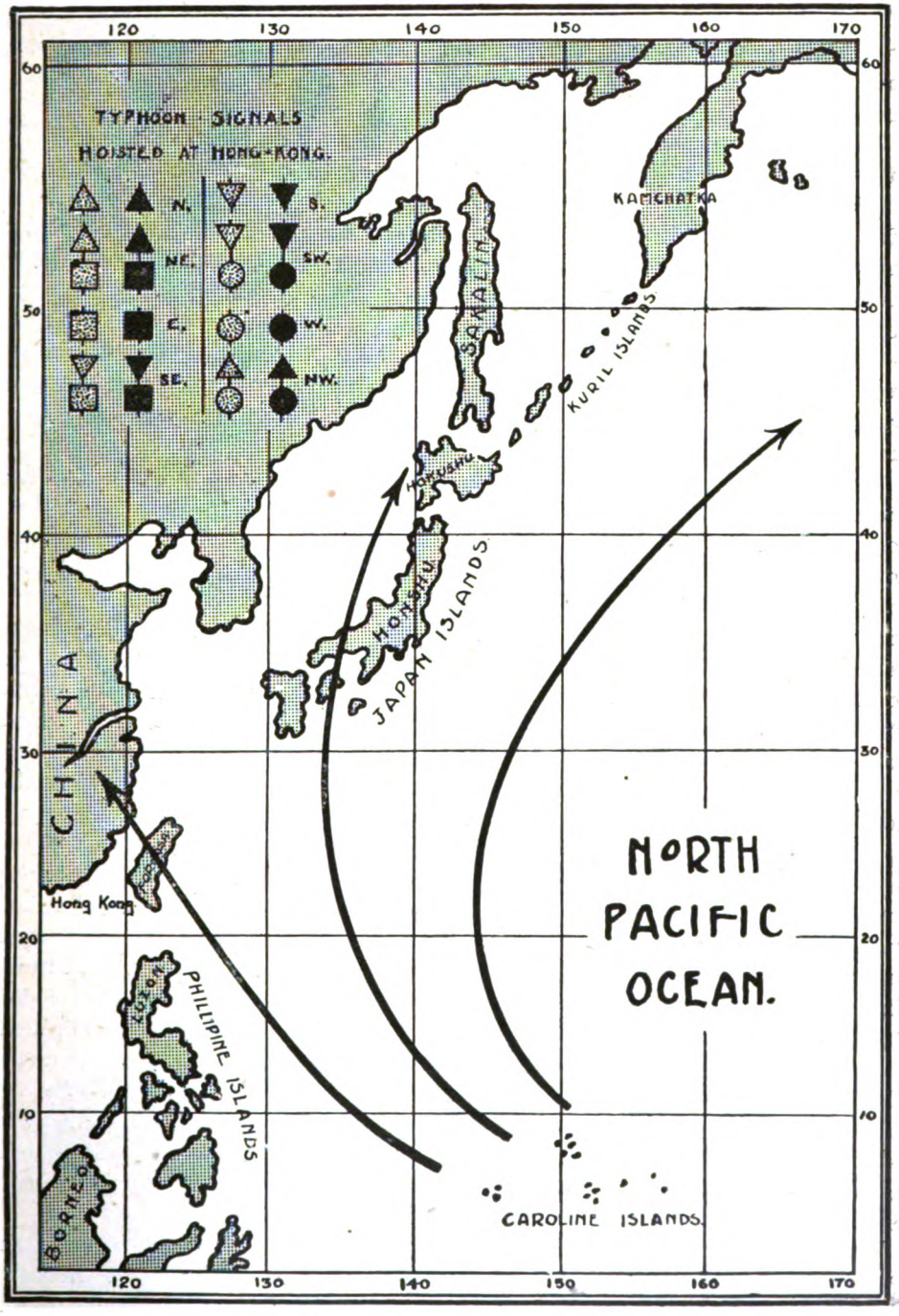

CHART SHOWING THE REGION AFFECTED BY THE TYPHOON.
POINT OF ORIGIN AND DIRECTION OF ITS TRAVEL.

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My inexperience cost me rather a bad ducking, for one wave caught me and brought me to my knees. The water trickled out of my sleeves and trousers-legs, and the wind seemed determined to strip me of my clothes. So I moved round to the leeward.

Since we came round to the wind the motion of the vessel had altered. The roll from side to side was less marked, but she would duck her head and the propellers would come out of the water, then the racing of the engines would shake the whole boat. Once when she ducked the whole of the fo'castle-head disappeared in the water, and then rising again the water poured off like a miniature Niagara. The wind was so fierce that the crests of the waves were whipped off and driven before it with a force that made drops of water feel like leaden bullets.

One would see a mountain of water advancing, and watch it fall with a crash over the deck and deck-houses, pour through the alleyways to the scuppers. Number 1 hatch was stove in, and the mate fairly raved. In the cabins boots and shoes, stools and oddments swished about in the water.

I went to my cabin to send word ashore that the typhoon had struck us, but couldn't work as all the insulators were wet. The chief was alarmed at the sparking across the insulators and begged me to desist. So I shut up shop. For five solid hours were we submitted to this buffeting, and about half-past ten at night there was a lull. The wind vanished and the sea became reasonably calm, so we went to our bunks. But shortly before midnight it came on the starboard side with renewed vigour. The strain on the ship must have been tremendous. One could hear the bulkheads creaking, and through it all the great syren moaned as the wind tugged at the lanyard. Sleep was out of the question, for not only was the noise terrific but one had to hang on to the bunk or be pitched out.

Not until five o'clock in the morning did we run out of it, and then we settled down to a couple of hours' nap.

We had come clean through the centre of the typhoon!

It was a sore-headed and grumpy crowd that met at the breakfast table that morning, and the purser said to me: "Now you know what a typhoon's like I guess you won't be anxious for an *encore*." I agreed that I'd spent a restless night and had a marked objection to losing my beauty sleep, and mentioned incidentally that I'd intercepted a message about it the day before. "What?" he exploded, "you got a typhoon warning and kept it to yourself?" I nodded.. "Well, if the old man ever gets to hear of it he'll make you feel like five cents in the dollar. You've missed the finest chance you're ever likely to get of showing him what you can do." Realising the significance of this remark, I felt at a discount right there, but I made a mental resolve to grab Mr. Opportunity by the forelock next time he came my way, and make him help me to redeem my slip. It was not until several weeks later, however, that I got another chance.

We were returning to the Orient after spending some time in ports on the Pacific coast of America and Canada, and once again the skipper found the barometer of more than usual interest. Apparently he had learnt something in the States, for he sent a quartermaster along with a message telling me to get a weather report from Choshi, in Japan. Although this was well beyond the normal range

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of my set I was able to get a message through and copy the reply. This I sent to the skipper, who was now on the bridge. He sent it back, saying that it was no good, the particulars he wanted were not given. So I called up Choshi again, but this time there was no reply ; seemingly the operator had been struck deaf and dumb.

The second officer (who usually looks after meteorological matters) now came along and said the skipper was "cussing a treat." "For God's sake," he added, "get some more dope, or he'll bust his bellows." So I did my best to get through, but all to no purpose. While re-tuning my receiver I caught a feeble signal, and recognised my own call letters. It was the s.s. *Sherbet*. The operator had heard my efforts to get through to Choshi, and wanted to know what kind of weather we were having. I told him in unofficial parlance what I thought of it, and asked how things were his way. "It's hell with the lid off down here," he replied. "Get me an official weather report from your navigating officer and I'll do the same."

This cheered me up a bit, so I asked the second officer to "do the needful." After a brief interval the messages were exchanged, and, as luck would have it, I got all the skipper wanted, and more. The two references fitted together admirably, and clearly showed the skipper that we were on the track of a typhoon once again ; so our course was altered accordingly. We managed to dodge it nicely, and got nothing worse than a bad blow.

The chief came along to my cabin and said, "Sparks, if ever you want a testimonial about that wireless you go to the old man. He's up there chuckling and rubbing his hands and can't find anything too good to say about it."

Next day we were doing a good fourteen knots when the look-out spotted a signal of distress to port. We veered round to investigate, and found a Japanese schooner with her masts broken and all her tackle overboard. She hadn't missed that typhoon !

We couldn't tow her at fourteen knots, and with 360 bags of mail we couldn't delay ; so we sent a message to the nearest coast station and got assurance that help would be sent.

We got to Yokohama twenty-three hours late, but we'd dodged the typhoon, and converted the Skipper—so did I worry ? Not a bit !

SIGNAL HILL, HONG KONG. WEATHER WARNINGS ARE HOISTED FROM THE SUMMIT.

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PERSONALITIES IN THE WIRELESS WORLD

DR. NICOLAAS KOOMANS

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THE progress of wireless telegraphy in the Netherlands owes much to the support of Dr. Nicolaas Koomans, who from the first days of Senatore Marconi's great invention has followed its progress and maintained a firm belief in the usefulness of this form of communication.

Born on December 18th, 1879, at Delft, Dr. Koomans studied mechanical and electrical engineering in his home town, receiving his certificate for these subjects at the age of twenty-one. During the next two and a half years he held positions as Assistant Instructor in Geometry and Assistant in Physics and Electrical Engineering at the Technical High School at Delft, subsequently entering the Government Telegraph Service as an Engineer.

In 1908 he graduated at the Technical High School at Delft, as Doctor in Technical Sciences, on the strength of a dissertation "Regarding the Influence of Self-Induction in Telephone Conducting-Wires." Dr. Koomans is joint founder and editor of the monthly *Review of Telephony and Telegraphy*, which, originally intended to be international in its scope, has been limited to the Netherlands by reason of the war. He is also joint founder and member of the Managing Board of the Dutch Society for Radiotelegraphy and a member of the International Electro-Technical Commission. Dr. Koomans further holds an appointment as Instructor in Physics and Theoret cal Electrical Engineering at a school conducted by the Dutch Post and Telegraph Administration for the instruction of higher officials.

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The Evolution of the Thermionic Valve (II.)

By R. L. SMITH-ROSE, B.Sc., A.R.C.S., D.I.C., Student I.E.E.

Read before the Students' Section of the Institution of Electrical Engineers on January 22nd, 1918.

NOTE.—The first part of this valuable paper appeared in our April issue, pp. 10 *et seq.*

THE FLEMING OSCILLATION VALVE.*

PROFESSOR J. A. FLEMING in 1904 was the first to apply these phenomena of thermionics to the rectification of alternating electric currents, whether of high or low frequency.† The device which he made to effect this may take one of several forms, some of which are shown in the sketch, Fig. 3, and the photograph, Fig. 4. It consists of an ordinary carbon filament incandescent lamp provided with a separate insulated electrode, in the shape of a flat or cylindrical metal plate, or another carbon filament, sealed into the bulb. When the carbon filament is rendered incandescent by a source of electric current it will be found that a single cell will pass a current through the vacuous space between the insulated electrode and the hot filament, provided that the negative pole of the cell is connected to the negative side of the filament. If the connections of the cell are reversed, practically no current passes, the small amount of current obtained being due to

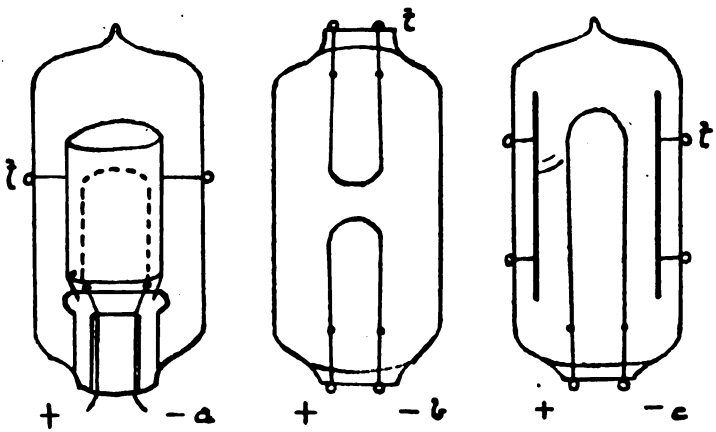

FIG. 3.

* J. A. Fleming, *Principles of Electric Wave Telegraphy and Telephony*, 2nd Edition, p. 476.

† See British Patent 24,850, 1904.

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positive ions formed from the residual gas in the bulb. This is what we should expect from the fact that the hot filament is emitting negatively charged particles, and in order to draw these across the gas space to the cold electrode the latter must be raised to a positive potential with respect to some portion of the incandescent filament.

The space between the cold and hot electrodes, therefore, possesses unilateral conductivity, and the arrangement acts as an "electrical valve," passing electric currents in one direction but not in the opposite direction. Fleming next found that this device could be used, on this principle, to convert electric oscillations into unidirectional currents, which may then be detected by means of an ordinary galvanometer.

The arrangement of connections for effecting this is shown in the diagram, Fig. 5.

The oscillation valve O has a sensitive galvanometer G, placed in series with the secondary coil S, of an oscillation transformer, connected between its metal plate or second electrode and the negative terminal of the carbon filament. If electric oscillations are induced in this secondary circuit by a primary coil p, then, when the carbon filament is rendered incandescent by the battery B, only one half of the oscillatory current is allowed to pass through the gas space, viz., that in which the movement of the negative electricity is from the carbon filament to the

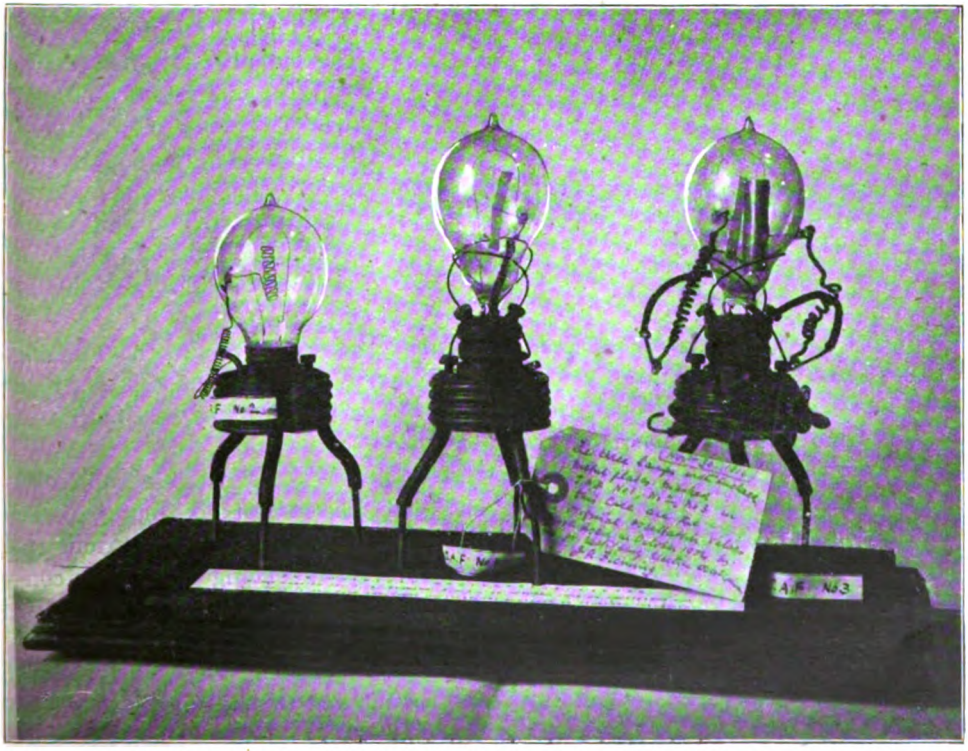

FIG. 4. ORIGINAL OSCILLATION VALVES USED BY DR. J. A. FLEMING, F.R.S., IN 1904.

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second electrode. The galvanometer has passing through it a flow of electricity in one direction, and its coil or needle will, therefore, be deflected.

For use as a receiver in radio-telegraphy the primary coil *p* is connected in the antenna circuit between the aerial wire *A* and the earth connection *E*. The secondary circuit of the oscillation transformer is closed by a condenser *C*, adjusted to give resonance with the frequency of the incoming waves. The valve is connected as shown in the diagram, a telephone being inserted at *G* to give audible reception of signals.

The incoming electric waves excite oscillations in the antenna which are transferred to the secondary circuit *sc*. These oscillations are rectified by the unilateral conductivity of the vacuum valve and each train of oscillations produces a single unidirectional rush of electricity through the telephone receiver, producing a click.

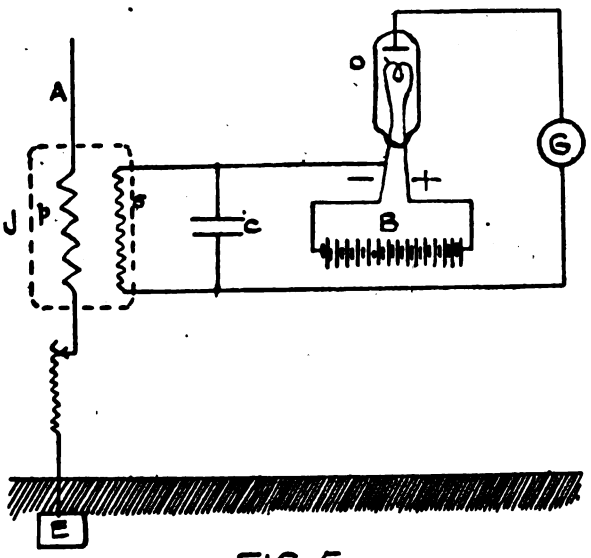

FIG. 5.

The receiver diaphragm, therefore, will vibrate at a frequency equal to that of the trains of oscillations received, that is, equal to the spark frequency of the wireless telegraphic transmitter from which the signals are being received. The sound heard in the receiver will, therefore, be a low buzzing tone or a high musical note, according to this spark frequency, and the tone will be cut up into the dots and dashes comprising the signals, as sent out by the transmitting key.

While this property of *unilateral conductivity* enables us to use the Fleming valve as a rectifying detector of electric oscillations, we may also make use of it in another manner, depending upon the fact that the gas space inside the bulb does not obey Ohm's Law as a conductor.

If we apply a steadily increasing electromotive force between the second (cold) electrode and the filament (cathode) we find that the current does not increase uniformly, but rises fairly quickly to a maximum value (the saturation current for the gas space), after which it falls off very slowly. Corresponding to this, the conductivity or the ratio of current to voltage of the gas space rises to a maximum and then falls off.

Fig. 6 shows the current and conductivity curves taken by Professor Fleming, for an oscillation valve with a metal cylinder surrounding the carbon filament, the latter being heated to different temperatures. The valve is more completely unilateral the colder the metal cylinder is kept, for obviously, if we allow this cylinder

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to become heated by radiation from the filament, it will itself commence to emit ions and the current between the filament and the second electrode will not be entirely in one direction.

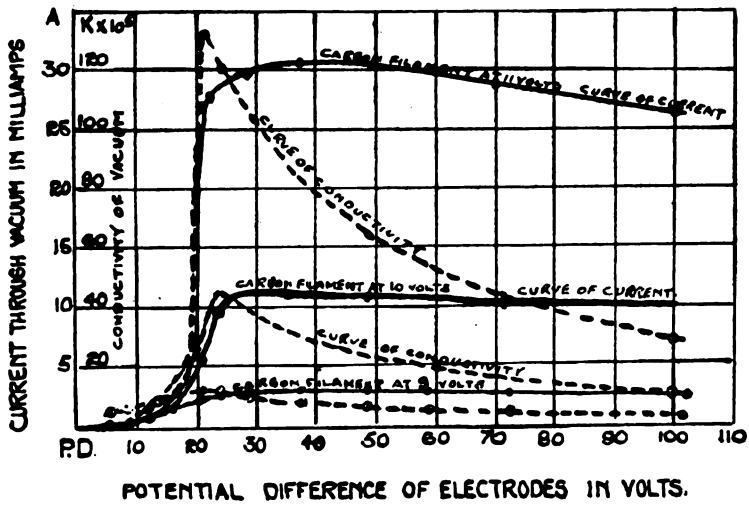

FIG. 6.

Now, it will be seen from the current - voltage characteristics that the curvature is not constant, and we can find a point near the " knee " of the curve at which the slope of the curve on one side of the point is much greater than on the other side. This point corresponds to a certain steady voltage applied between the plate and the filament, and a corresponding steady current flowing through the valve, and the difference in slope of the curve on the two sides of the point indicates that if the *PD* between plate and filament be alternately increased and decreased by a small amount, the corresponding increase in current through the valve in the one case will be much greater than the decrease in current in the other case.

If this alternate increase and decrease in voltage is effected by superimposing an alternating voltage on the steady voltage, then the corresponding currents have a mean value which is greater than the current corresponding to the steady voltage alone. Hence, if we have a telephone receiver in series with the valve plate circuit under these conditions, a click will be heard in the receiver every time the alternating voltage is applied to the valve electrodes.

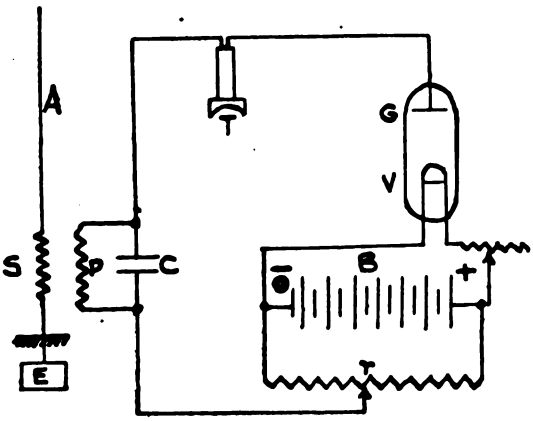

FIG. 7.

We can, therefore, apply this property of the valve having a non-linear characteristic for the detection of electric oscillations, the circuit arrangements being as shown in Fig. 7. One side of the oscillation circuit *PC* is connected in series with a telephone T_1 to the second electrode

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of the valve, while the other side is connected to the sliding contact on the resistance r shunting the battery B which supplies the heating current for the filament. By this means we are able to apply an adjustable steady voltage across the gas space in the valve and also, from the oscillation circuit, superimpose on this an alternating voltage of frequency equal to that of the oscillations set up in the coupled antenna circuit.

If, then, we adjust the slider on the resistance r so that the voltage applied to the valve corresponds to the point on the characteristic curve at which a sudden change of curvature takes place, then every time oscillations are set up in the circuit PC the effective value of the current through the telephone will be increased and a click will be heard in the receiver. Thus, when the complete circuit is adjusted to receive radiotelegraphic signals, the tone heard in the receiver will be of a frequency equal to that of the trains of electric waves received, *i.e.*, equal to the frequency of the spark at the transmitting station.

With a good valve and by carefully adjusting the conditions under which it is operating, Fleming found that this arrangement provides a more sensitive detector than that employing the unilateral conducting property of the valve.

Fleming found later that greatly improved results were obtained when the valve was constructed with a tungsten filament and an insulated copper cylinder surrounding it.* This is due to the fact that the tungsten can be raised to a much higher temperature than carbon without volatilisation and gives a much greater electronic emission, and, as will be seen later on in the paper, this type of thermionic valve is almost universally constructed at the present time with either a tantalum or tungsten filament.

THE "AUDION" DETECTOR AND AMPLIFIER.

The next step in the evolution of the thermionic valve was made by Dr. Lee de Forest, of the United States of America, and consisted in the introduction of a third electrode into the evacuated bulb. Lee de Forest had been working on the simple rectifying valve containing a metal or carbon filament and one insulated electrode (already described) at practically the same time as Fleming, and his results were first described in a paper before the American Institute of Electrical Engineers in October, 1906.† Considerable controversy has since then ensued as to the relative priority of the inventions of the Fleming valve and the "Audion," the name assigned to the valve by de Forest; but this has now been settled in favour of Fleming for the original valve, Lee de Forest having the credit of introducing another insulated electrode into the bulb, thereby transforming it from a rectifying valve into a kind of gas relay, having an amplifying effect on the received oscillations.

This modification was described by de Forest in 1913 before the Institute of Radio Engineers.‡ This third electrode consists of a metal strip or wire bent into the form of a "grid," and situated between the filament and the second electrode or "plate," and it serves as an independent path by which the electric oscillations are introduced into the vacuous space within the bulb.

* British Patent 13,518, 1908.
† Lee de Forest, *Electrician*, 58, p. 216 (1906).
‡ Lee de Forest, *Electrician*, 72, p. 285 (1913).

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In studying the action of this "grid" we may consider the diagram shown in Fig. 8, which shows a simple method of connecting up the audion for the reception of electric oscillations.

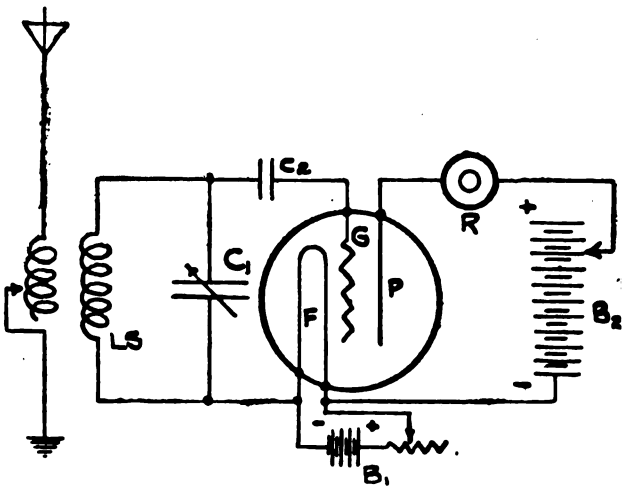

FIG. 8

The incandescent lamp bulb contains a tantalum filament F, which is lighted by a battery B_1 of 4–15 volts. Close to one side of, and parallel to the plane of, the filament is mounted a small rectangular nickel plate P. This plate is connected through the telephone receiver R to the positive terminal of the dry-cell battery B_2, giving from 15–40 volts, the negative terminal of this battery being connected to the positive side of the filament. Between the filament and plate is mounted the third electrode, G, a grid-shaped wire or perforated plate of nickel, at approximately one-sixteenth of an inch from both the plate and filament. Leads from the condenser C_2 in series with the grid G, and the negative end of the filament, are connected to the terminal of the variable condenser C_1, which is adjusted to place the circuit LSC_1 in resonance with the received oscillations induced in the coil LS.

Now when no signals are being received the grid will be practically at the same potential as the negative side of the filament, which we will regard as our "zero" of potential, and a certain steady current will be flowing through R in the plate circuit, the value of the current depending upon the dimensions of the valve and electrodes, the temperature of the filament, the nature and pressure of the gas, and the voltage of the battery B_2.

If now the grid be raised to a positive potential with respect to the negative end of the filament, the intensity of the electric field between G and F will be increased, and more negative ions will be drawn across this space than previously. Some of these will be drawn into the grid giving a small current in this circuit, but the majority of them will pass through the perforations in the grid and will subsequently be attracted to the plate under the field created by the battery B_2. The net result, then, of imposing a positive potential on the grid will be to increase the current in the plate circuit, and within certain limits the greater the potential on the grid the greater is the increase in current. Similar reasoning will make it evident that the effect of raising the grid to a negative potential with respect to the negative side of the filament will be to decrease the current in the plate circuit.

A typical characteristic curve for an "audion" valve, showing the variation of current in the plate circuit with the potential applied to the grid, is shown in

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Fig. 9. Normally, the grid is practically at zero potential indicated by the point *P* on the curve.

Now, when electric oscillations are induced in the circuit LSC_1 from the receiving aerial circuit, these are rectified between the grid and the filament and accumulate a negative charge on the grid and the connected plate of the condenser C_2. This decrease of the grid potential causes a corresponding decrease in the plate current, as indicated by the above curve. As the train of oscillations dies away, the charge on the grid leaks away relatively slowly by means of the positive gaseous ions within the bulb, thus allowing the plate current to return to its normal value. This function takes place for every train of damped oscillations received, and hence the current in the telephone receiver alternately decreases and reassumes its normal value, at a frequency equal to that of the spark at the transmitting station, and the telephone diaphragm will therefore vibrate at this same audible frequency.

This three-electrode valve may also be used as a detector without employing the grid condenser C_2. In this case the grid potential is maintained normally at one of the bends *A* or *B* of the curve in Fig. 9 by means of a separate adjustable battery. Then, as the incoming oscillations cause the grid potential to vary alternately on either side of this value, the resulting changes in plate current, on account of the asymmetry of the curve, are not symmetrically alternating about the normal value, but have a direct current component. Hence each train of oscillations received produces a unidirectional impulse through the telephone receiver, and the diaphragm of the latter will vibrate at the spark frequency of the transmitter.

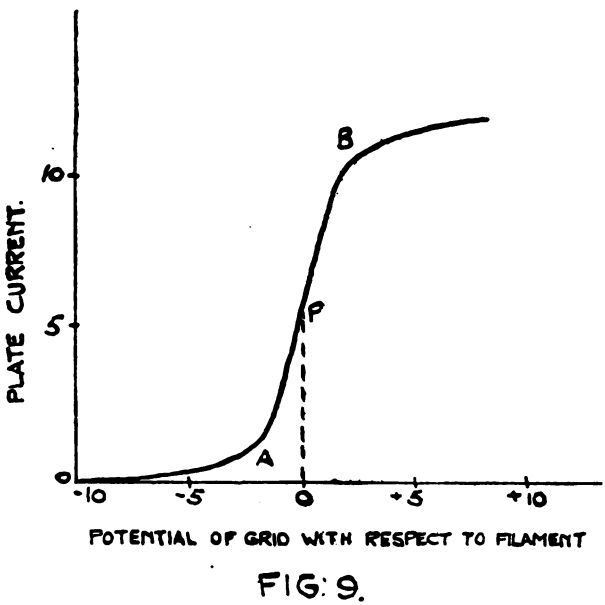

FIG. 9.

Whichever arrangement is used, the result will be the same in that a note of audible frequency will be heard in the receiver cut up into dots and dashes in accordance with the signals sent out by the transmitting key.

(*To be continued.*)

ACCORDING to the *Journal Telegraphique*, the number of wireless stations opened on December 31st, 1917, was 6,113, of which 687 were coastal stations, and 5,338 on board ship, the remaining 88 being inland.

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Digest of Wireless Literature

Kelvin as a Teacher.

At the Ninth Kelvin Lecture, delivered by Professor Maclean at the Institution of Electrical Engineers, many interesting facts were brought to light concerning the great scientist. Lord Kelvin, as many of our readers will remember, was the first to send a paid wireless message, and Professor Maclean happened to be the recipient.

In the opening words of his lecture, Professor Maclean stated that during the fifteen years he acted as Lord Kelvin's chief official assistant he attended every lecture he delivered, both to the Ordinary and to the Higher Classes, and always took notes. The lecturer then went on to give many interesting particulars regarding Kelvin's methods as a teacher. There was no systematic course of instruction in the laboratory, said the speaker. A number of Thomson scholars were always engaged in experimental research, and new students were attached singly or in pairs to each scholar, and had to help in making observations and devising new apparatus. In this way the students got practice in woodwork, sawing, planing, and fitting. Nothing was done for them. If a student had to solder he was required to do it himself, and with resin, no chloride of zinc being allowed. True, he had an opportunity of seeing how it was done by a senior student or scholar, while he was at the stage of looking on and helping. The Kelvin attitude to beginners is quite explicitly enunciated in a letter, wherein he says, "Let any students, if there be any, stand by and learn, and help when they can." Since then, said Professor Maclean, he had had 18 years' experience in the Royal Technical College, Glasgow, where students are put through their regular course of laboratory practice. Sheets of instructions are given them beforehand, apparatus laid out to be connected up by the students themselves, rules given for entering results and drawing graphs, all of which must be entered in special laboratory books which are examined and criticised by the teaching staff at frequent intervals during the session. Kelvin's method, or should he say, want of method, went on the speaker, had many disadvantages, but the more modern methods prevalent in every British laboratory are by no means free from defects also.

In the course of his lecture, Professor Maclean mentioned that during the session 1897–98 Mr. V. J. Blyth and he conducted experiments on coherers and spark discharges. The main object of the experiments was to determine whether the transmission was more effective in the direction of the spark, or at right angles to the direction. On June 3rd, 1898, Lord Kelvin visited the Needles Station and sent from there to Professor Maclean the first paid Marconigram as follows:—"Maclean, Physical Laboratory, University, Glasgow. Tell Blyth this is transmitted commercially through ether from Alum Bay to Bournemouth and by postal

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telegraph thence to Glasgow. Kelvin." A photograph of the original telegram and some notes regarding the occasion were reproduced in THE WIRELESS WORLD for December, 1915.

RADIO TELEPHONY.

Dr. Alfred N. Goldsmith, Director of the Radiotelegraphic and Telephonic Laboratory of the College of the City of New York, continuing his series of articles on Radio Telephony in the *Wireless Age*, deals in a recent issue with a number of points connected with reception. Speaking of selectivity, Dr. Goldsmith says that there is a fairly sharp conflict between the requirement of loud signals and extreme selectivity. The first of these generally requires sensitive detectors and powerful amplifiers used with close coupling to the antenna system, while the second tends in the opposite direction. Nor does beat reception solve this problem, as will be evident below. All that can be said is that a rational compromise must be effected in every case, this to be determined by the operating conditions in the neighbourhood of the receiving station. Thus the amount of interference in the vicinity of the receiver is an extremely important factor in determining the amount of power required at the transmitter to cover the desired distance. This is a factor which is often overlooked in the design of stations.

Interference from spark stations disturbs radiophone reception less than might be expected, partly because the dots and dashes constitute a more or less intermittent disturbance through which portions of the words can be heard, and partly because of the resulting "assistance of context" effect. Sustained wave station interference is, however, very serious, since this causes a continuous musical note by the beats with the incoming radiophone frequency, and this continuous musical note cannot be tuned out either by ordinary or beat reception, being a physically present phenomenon caused by two frequencies *external* to the receiving station In the neighbourhood of a large arc radiotelegraphic station, this may become a very grave matter, particularly if compensation waves are used by the arc station in transmission. In this latter case, there will generally be produced a long series of overtones of both the sending and the compensation waves, and there is very likely to be continuous beat interference. The author is very much of the opinion that radiation at non-useful frequencies should not be permitted, since the growth of the radio art will be much hampered thereby. Furthermore, provision should be made in all sustained wave stations to avoid the production of these series of overtones (which, it may be mentioned, are frequently not harmonics, but fall at non-integral multiples of the main and useful frequency).

With regard to telephone receivers, it might be expected that there would be no great difference between the various telephone receivers used in radio sets, so far as speech reception was concerned, but this is far from being the case. In addition to marked differences in intrinsic sensitiveness, the receivers show differences as to the extent to which they distort speech and the relative extent to which they respond to the sudden shocks caused by heavy strays. Generally speaking, the receivers with diaphragms of moderate thickness give good articulation, moderate sensitiveness, no inordinate response or "singing" when stray impulses

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are received, and are robust. More sensitive receivers with very light diaphragms tend to give " tinny " speech, and more than proportionate response to impulses.

Electrical Physics of the Atmosphere.

A paper on the above subject was read recently by Mr. J. E. Taylor before the Institution of Post Office Engineers.

Mr. Taylor remarked that a knowledge of electrical effects in the atmosphere is very necessary to telephone and telegraph engineers, in order that the harmful effects of such phenomena on electrical communication might be guarded against and overcome. Effects due to electric stress, ionisation, lighting and other atmospheric sources of disturbance, are of great consequence in wireless telegraphy. The general constitution of the atmosphere was discussed in some detail, the constituents of the lower atmosphere being of special importance. Evidence based on meteor trains, auroræ, etc., was quoted to show the great height of the atmosphere, differences in constitution being confirmed by spectroscopic observations. The effect of radium emanations in the atmosphere and experiments showing the decomposing power of sunlight next received attention. The effect of temperature gradients and the isothermal layer were explained, and curves obtained at Kew were presented, showing the nature of electric atmospheric stresses and their dependence on weather conditions. Ionisation of gases as an index of chemical activity, changes in gaseous conductivity accruing from slow or rapid chemical action, and the effect of the degrees of gaseous conductivity met with in the lower atmosphere are most important. The causes of atmospheric ionisation in the lower regions were discussed. It was pointed out that *permanent* ionisation involves maintaining a constant supply of energy. An interesting analysis of thunderstorms and lightning phenomena followed. Various theories of thunderstorms, such as the " breaking drop " theory of G. C. Simpson, were given, but it was pointed out that the phenomena are not fully explained; a suggested cause of thunderstorms and the formation of hailstones, based on the decomposition and recombination hypothesis, was put forward. The conditions conferring immunity from lightning effects, the functions of lightning rods and other protective devices were explained, and the standard methods of protecting telegraph and telephone lines were subjected to some criticism. Finally, an analysis was made of the vexed question of wireless strays and disturbances, and an account was given of the Dieckmann antenna screen. The Paper concluded with some account of magnetic storms, and methods of recording meteorological data.—*The Electrician.*

The Detection of Undamped Waves.

With reference to our note in the " Digest of Wireless Literature " for April, entitled " The Detection of Undamped Waves," this idea is covered in England by the Patent number 11453 of 1913, granted to Marconi's Wireless Telegraph Company, Limited, and C. S. Franklin.

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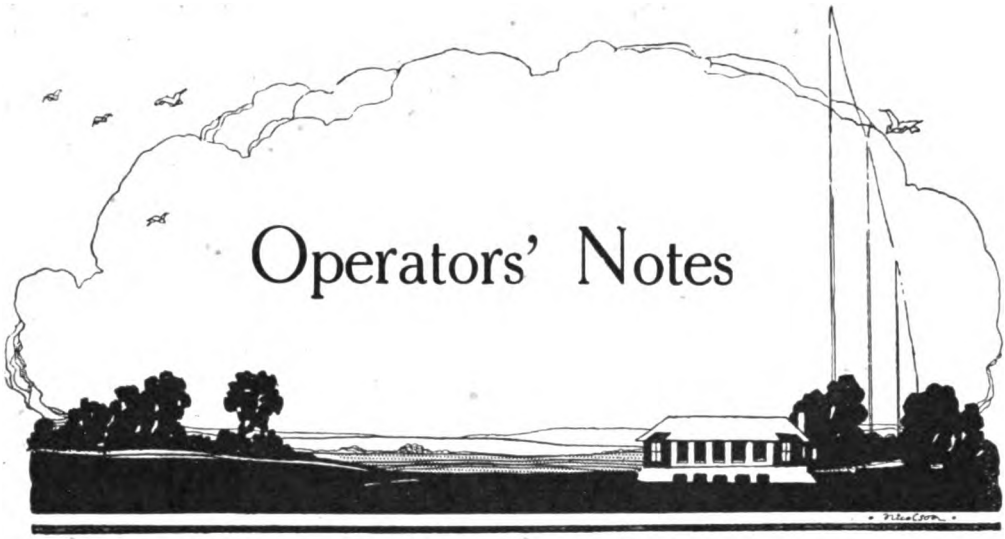

Operators' Notes

Tools and How to Use Them.

By HAROLD WARD.

INITIATIVE, ingenuity, neatness and accuracy are the four essential qualifications which go to make a good craftsman, and only experience can teach the correct and proper use of tools, as practically all repairs require different handling. To those without any previous practical experience, the following hints should prove of use. It behoves all operators to familiarise themselves at once with the tools in their charge, and not wait until the necessity to use them arises.

Blow Lamps.—When heating up a blow lamp, do not hold the flame underneath that part of the jet which contains the wick. A scorched wick will not " feed " the spirit properly. Two or three turns of thick copper wire round the nozzle of jet will give a slightly better flame. If no methylated spirit is available, do not imagine the lamp is useless. It will work with almost any form of alcohol, the writer on one occasion having successfully employed brandy, there being no other suitable spirit on board !

Centre Bits.—These are only intended for boring holes in wood, and must on no account be used for metal.

Wood-handle Chisel.—This must not be used as a screwdriver. Do not hit the handle of chisel with a hammer, as boxwood splits. A block of wood, or, better still, a mallet made from a piece of hard wood, should be used. This tool is not for cutting metal, a cold chisel being supplied for that purpose. A chisel is of no use for cutting ebonite, as this material splits too readily.

Cold Chisel.—A cold chisel is constructed entirely of metal and has no handle. It is primarily intended for cutting fairly soft metal, such as copper strip, and is useless for hardened steel. It is often quicker and better to use the cold chisel in place of the pliers when cutting thick copper wire.

Counter-Sink.—This is a small conical drill used for finishing off holes intended for flat headscrews or rivets, so that their heads may lay flush with the surface.

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Drilling.—When drilling holes in material it is advisable to give the drill a start by using a punch first. A useful punch can be made by hardening the tip of a fair-sized steel nail, to do which the point should be heated and plunged into cold water several times. Care must be taken to hold the drill steady, as a very slight jerk will snap it.

Files.—Filing is an art which can only be acquired by constant practice, and a considerable amount of judgment is necessary to produce satisfactory results. The greatest difficulty in filing is to file flat. The article to be filed should be held securely in the vice about on a level with the elbow, care, however, being taken not to exert too much pressure with the jaws for fear of doing damage to the surface of the material. Stand with the left foot a little to left of the vice and with the right foot a little to the rear. Hold the file in right hand with the knuckles down and the elbow close against the side. The other end of file is steadied with the left hand. Start with firm, steady strokes, allowing the body to move with the file, taking care to keep the pressure even and the direction of each stroke as uniform as possible. Only the forward stroke should cut, so slightly relax the pressure on the return stroke without lifting the file. When filing contacts, bear in mind that platinum is more valuable than gold, so file away no more than is absolutely necessary. Use an old file for ebonite, as it quickly clogs. Flat files are used for flat surfaces, and most have one smooth "safety" edge to permit of their being used close up to a corner without doing damage to the side of the article. Half-round files are used for filing inside holes or curves and the strokes should be made with a sweeping motion from side to side in addition to the backward and forward motion. "Rat-tailed" round files are used for enlarging circular holes, such as the eyes of lugs. Triangular files are used for special jobs, such as clearing corners of square holes, slots, etc., or for notching a wire or rod prior to sawing or breaking it.

Hack Saw.—Though essentially a metal saw, this tool can be successfully employed in cutting wood and ebonite, provided care is exercised in using it. When cutting deeply into metal or wood a little grease applied to blade lightens the work considerably. Previous to commencing a cut see that the blade is tightly fixed with teeth pointing in a forward direction. Use in a manner similar to a file—*i.e.*, exerting the cutting pressure on forward stroke only and steadying the saw with the left hand. It is advisable to make a small notch with a file before starting to saw a piece of metal. This ensures a clean start being made. Take great care to preserve an even motion, as a very slight twist will often break a blade. Relax the pressure when the cut is nearly completed.

Pliers.—These are supplied for use in twisting and cutting wires when jointing, and for holding small articles during filing or soldering. It is not advisable to use pliers for holding contacts during filing, as the hand is not sufficiently steady. Do not use your pliers as a hammer, nor for tightening up terminals, or the milling will become burred and unsightly. Thumb tightness is all that is required. Never use the cutting edges of a pair of pliers on hardened metal, as the knife edges are only made for comparatively soft wire.

(To be continued.)

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Wireless Telegraphy In the War

Spies and the Journalist.

Spies and spycraft are an ever-fruitful source of inspiration to the newspapers, probably because on this subject it is possible to write so much with so little foundation. A good story can always be made by equipping the spy with wireless telegraphic apparatus, and as now and then a genuine case comes to light, the tale generally proves acceptable.

There are fashions in "spy writing" as in everything else, and, as in the early days of the war every alien had concrete foundation for a gun in his back garden, so at the present time the same person is equipped with his transmitter and receiver for communication with "Berlin."

Always Berlin, you will notice, not Norddeich, or a German coastal station very many miles nearer, with which it would be much easier to communicate!

A great deal of unnecessary scaremongering is done by "popular" writers, who, referring to what is alleged to be said by experts, cover their writings with a false appearance of authenticity. As an example of the pseudo-scientific nonsense served up for the delectation of the masses we would quote the following passage from a weekly journal of large circulation: "Personally I have no technical know-"ledge of such things, but I am told by those who are more scientific than myself "that the sending of a wireless message is not so conspicuous an affair as the "receiving of one. For this latter purpose a considerable installation is necessary— "a mast or other high erection to catch the message in its flight, whereas the sending "of one requires no such eye-arresting apparatus, and might be done from a box "like a large camera or accordion, which a man could carry under a cloak and "instal in a room with an outlook towards the sea."

Now this is exactly the reverse of the actual facts. The receiving of a message requires far less apparatus than the sending of one, and is far more difficult to trace. Any wireless transmission can be immediately detected. Perhaps the obliging and more scientific friend of the author will oblige us with particulars of the wireless concertina which, if nothing else, should be capable of fine tuning.

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As mentioned above, genuine cases occasionally come to light, such as that reported in a recent message from Paris. A wealthy foreigner was discovered to be in possession of a wireless receiving plant in his villa on the right bank of the Loire. With his valet he was promptly arrested and placed in prison at St. Nazaire.

PROGRESS IN FRANCE.

Writing of France reminds us that wireless progress in the land of our gallant Ally has not been slow during the war. The Eiffel Tower station—well known to amateurs in peace time by its daily transmission of time signals—is now infinitely better equipped than was the case prior to the outbreak of hostilities.

Great credit is due to the organising genius of Commandant Ferrie, in charge of French military wireless, for the work he has done to improve the radiotelegraphic equipment of the French installations.

Press reports from the United States have now revealed the existence of a new giant wireless station, erected by the French Navy, on the coast of France near one of the American naval bases. The size of the station may be gauged in some measure from the fact that the metal pylons supporting the aerial are each 600 feet high, while the generating plant is said to be rated at 600 horse-power. The station will mainly be used for keeping in touch with America and American ships on the way to Europe with troops and supplies. Our Allies are proud of the fact that the whole plant took but six months to erect. Test messages have already been received in Australia, and it has been widely proclaimed that the new installation is the "world's greatest wireless"—a statement, by the way, to be taken with a pinch of salt.

This is not the first instance of signals from European stations being received in the Antipodes, several other cases having recently come to light. The cause of reception of wireless signals over such phenomenally long distances is not so much due to the increase in power of transmitters as to the enormous advance made recently in wireless reception.

Jules Verne, himself a Frenchman, missed great opportunities by being born before the days of Marconi, and we can imagine how he would have been inspired by the opening of this great electrical station for the communication of intelligence by invisible waves.

AN ENEMY FREAK BOAT.

On our next page we give an interesting and detailed drawing, which recently appeared in the *Graphic*, showing the construction and method of working a German crewless boat. Our readers will remember that we referred to an Admiralty report regarding one of these boats, some months ago, and it was at first thought by many that the vessel was controlled by wireless. This belief was strengthened by the fact that such vessels are practicable, the United States having purchased, some while ago, the inventions of John Hays Hammond, Junior, who had demonstrated such a vessel on the American seaboard. However, it afterwards transpired that the mechanism

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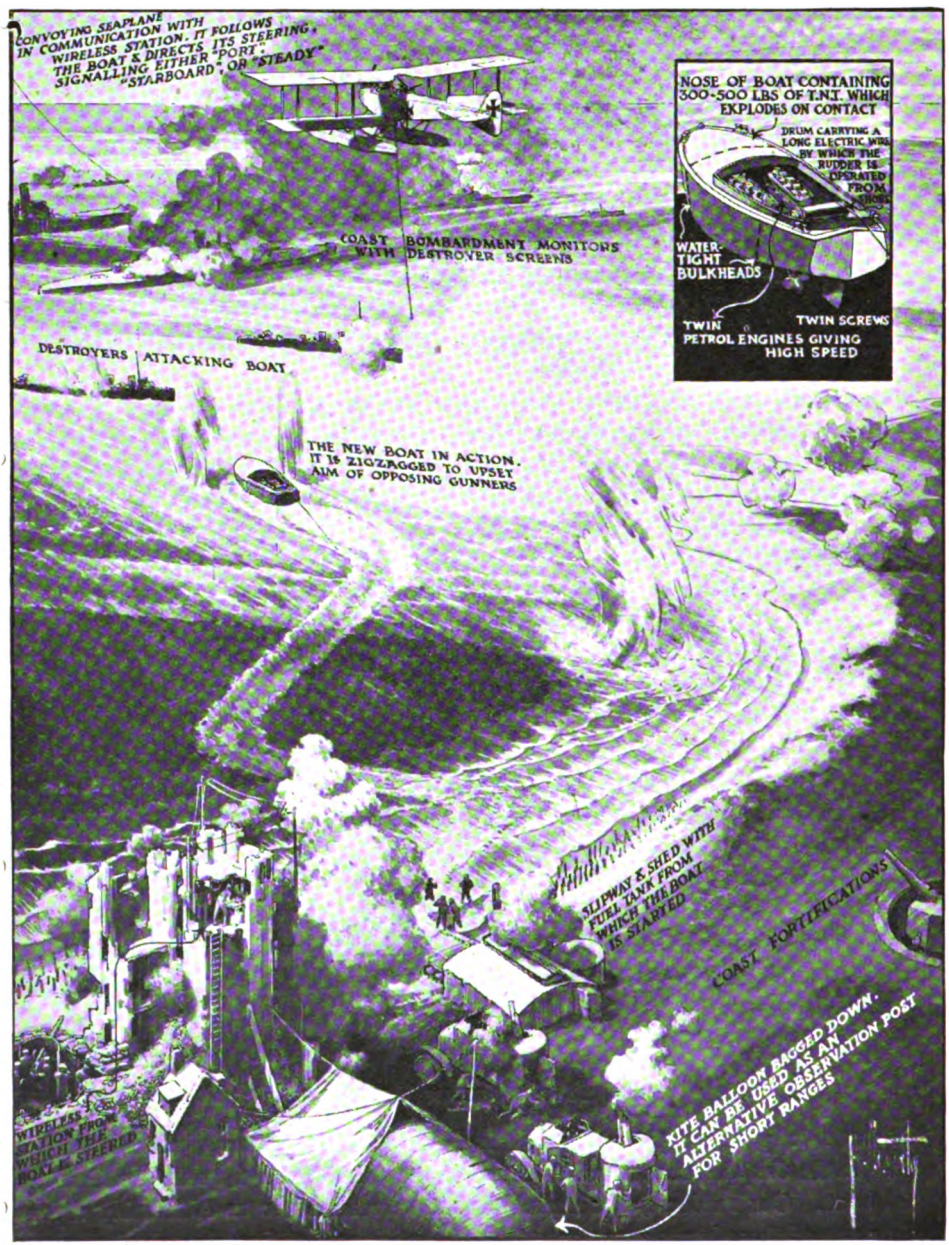
A German Freak Vessel


CONVOYING SEAPLANE IN COMMUNICATION WITH WIRELESS STATION. IT FOLLOWS THE BOAT & DIRECTS ITS STEERING, SIGNALLING EITHER "PORT," "STARBOARD," OR "STEADY"
COAST BOMBARDMENT MONITORS WITH DESTROYER SCREENS
DESTROYERS ATTACKING BOAT
THE NEW BOAT IN ACTION. IT IS ZIGZAGGED TO UPSET AIM OF OPPOSING GUNNERS
NOSE OF BOAT CONTAINING 300-500 LBS OF T.N.T. WHICH EXPLODES ON CONTACT
DRUM CARRYING A LONG ELECTRIC WIRE BY WHICH THE RUDDER IS OPERATED FROM SHORE
WATER-TIGHT BULKHEADS
TWIN PETROL ENGINES GIVING HIGH SPEED
TWIN SCREWS
SLIPWAY & SHED WITH FUEL TANK FROM WHICH THE BOAT IS STARTED
COAST FORTIFICATIONS
KITE BALLOON BAGGED DOWN. IT CAN BE USED AS AN ALTERNATIVE OBSERVATION POST FOR SHORT RANGES
WIRELESS STATION FROM WHICH THE BOAT IS STEERED

CREWLESS HUN BOAT LOADED WITH T.N.T. AND CONNECTED TO THE SHORE BY CABLE THROUGH WHICH IT IS ELECTRICALLY STEERED. THE COURSE IS SIGNALLED TO THE SHORE BY WIRELESS FROM A CONVOYING AEROPLANE.

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was controlled from the shore by a long cable, an aeroplane fitted with wireless serving for "spotting" purposes. Such vessels have a very limited range of usefulness, and for this reason are not often heard of.

THE TRACK OF THE "WOLF."

In our April issue we wrote of the exploits of the German raider *Wolf*, and mentioned that few if any of her victims seemed to have been fitted with wireless. A thrilling story has now been related to the Australian Press Association by two Australian officers who were captured by the raider and were liberated by the stranding of one of her victims off the coast of Denmark. From this account we learn that two vessels at least had radio apparatus, their messages being tapped by the *Wolf's* own operator. One, the *Matunga*, was tracked by her wireless and captured in order to obtain her coal, of which the *Wolf* was desperately in need. Parts of the account read like a Guy Boothby novel of the Southern Seas. Listen to this, for example :—

"The Germans had their plans carefully prepared in advance. With the "prize crew in charge, instead of our own navigators, and a German wireless operator "in the seat vacated by our own 'Sparks,' we followed the *Wolf* to a prearranged "destination. This proved to be a natural harbour on the north coast of Dutch "New Guinea, an ideal place for the purpose, as well as being the most beautiful "haven imaginable. At the entrance, less than a quarter of a mile wide, the "Germans placed a couple of small guard boats. On the higher of the two hills "that screened it from the sea they established a wireless plant and signalling "station. The seaplane carried by the *Wolf* meantime scoured the neighbouring "land and sea for a hundred miles around, while the transference of passengers "and cargo proceeded, the two vessels being lashed together."

And again, later in the story, we read: "After remaining several days off "Singapore and in the China Seas, the *Wolf* entered the Indian Ocean, and pro-"ceeded sufficiently far north to be able to pick up wireless messages from Berlin "and Constantinople. The officers were chagrined, however, that these included "no fresh instructions for them to follow. Although the *Wolf's* wireless was con-"stantly at work picking up messages it could not, of course, be used to send them "out without grave risk of detection. . . . The *Wolf*, after making various excur-"sions in which among others an American barque was sunk, rounded the Cape "of Good Hope, accompanied by the *Igotz Mendi*, and made for the Trinidad "Islands off the Brazilian coast. A wireless message was, however, intercepted "stating that Brazilian men-of-war had arrived there. Both vessels promptly "turned and went full speed south-east."

And so the account proceeds, the narrators describing how the *Igotz Mendi* and the *Wolf* eventually reached Europe; the former grounded on the Danish coast, and the latter managed to slip back to Germany. Thus ends a true tale, unsurpassed for dramatic interest by even the best pirate stories of fiction.

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How to Become a Wireless Engineer

Preparation for an Interesting Career

ALTHOUGH the life of a wireless telegraphist is highly interesting and attractive, that of the wireless engineer is even more so. While the operator spends most of his time on board ship, or in one particular land station, the engineer is required, in the course of his duties, to visit all parts of the world, frequently spending many months in wild and almost uninhabited parts of the globe, thrown on his own responsibility, and perhaps seeing no other white man from the beginning of the work to the end.

In view of the steadily increasing number of letters to the Editor asking for information regarding entry into the engineering staff of the Marconi Company, we have gathered together the following particulars, which will, we think, supply our readers' wants.

Firstly, it should be understood that the character and general education of the applicant are of the utmost importance, careful inquiries being instituted into both

A CLEARANCE IN THE JUNGLE AND THE FIRST STEP TOWARDS ERECTING A STATION.

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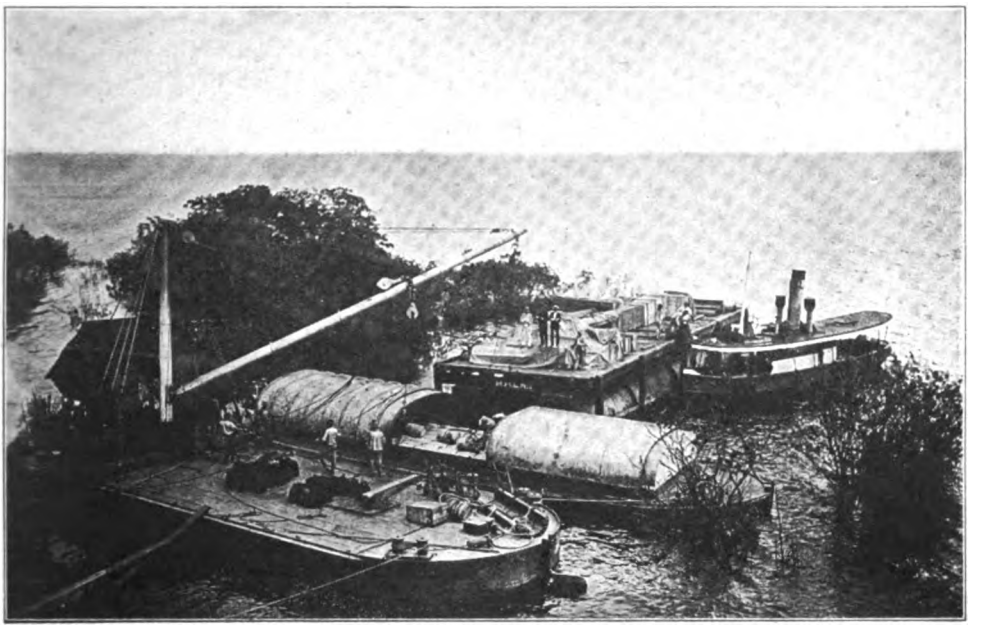

UNLOADING "WIRELESS" MATERIAL FOR A TROPICAL STATION.

of these subjects before the would-be engineer is accepted on probation. Secondly, it is essential that the applicant should be thoroughly trained in general engineering and qualified to acquire, from the particulars available during the early months of employment, the special knowledge of the Company's methods and practice, which he will need in his future work. The age of joining as a probationer varies from 21 to 25 years, and unless the applicant is of robust health, and willing to proceed on the Company's business at any time, to any part of the world, he will stand little chance of admission.

In view of the fact that engineers are employed in distant parts of the world, in many instances far from advice and assistance, they require to have a good working acquaintance with the many different branches of engineering. These include the construction of buildings, masts and machine foundations; the erection of masts, and installation of boilers, steam engines, oil engines, dynamo-electric machines and high-tension alternating and direct current electrical plant. They must, of course, in addition, understand the erection and tuning of wireless transmitting and receiving circuits. Experience has shown that for proper training it is necessary to devote at least two, and preferably three, years to college training in mechanical, electrical, and civil engineering subjects, and a further two years to mechanical engineering training in the workshops. A diploma in electrical engineering is necessary as evidence of competence. An engineer with only a college training has but a limited field of employment and little prospect of advancement. It is true that he may find occupation in research work, but even here the absence of practical experience will be a handicap in developing ideas for practical applica-

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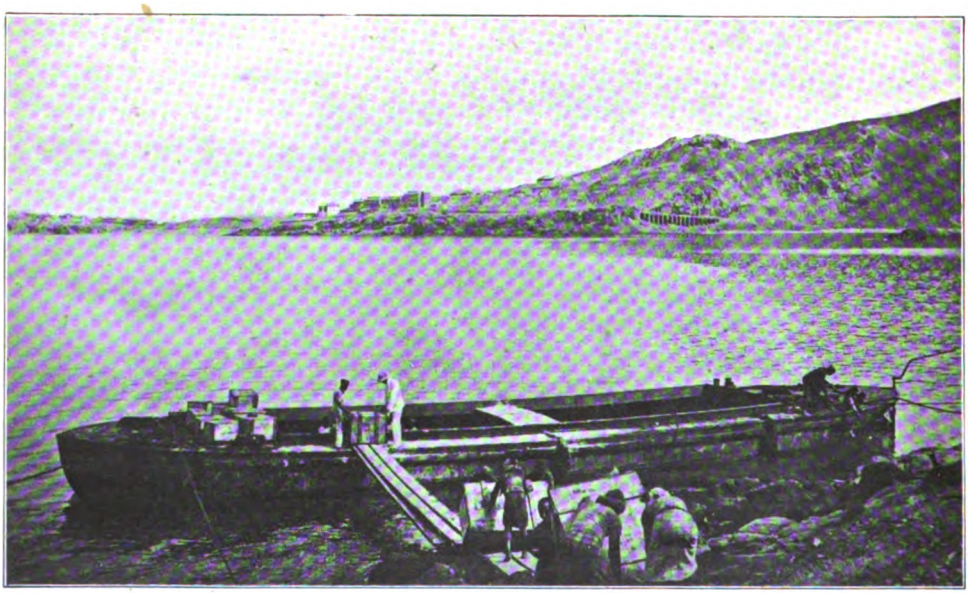
tion. Equally, an engineer with shop training alone is just as limited in his employment, for his training will not permit of his designing of new types of apparatus and, in fact, his field is limited to carrying out the rule-of-thumb operations which he has learnt by previous practice.

A suitable training for service with the Marconi Company's engineering staff can be obtained by attending the Degree or Diploma Course provided by many Universities and Technical Colleges, in combination with two years' whole-time employment in a good engineering works, either during or after the college course. Such a training is, of course, equally satisfactory for many other branches of engineering. The following is a list of some of the institutions providing a suitable engineering course :—

INSTITUTION.	COURSE.
	London.
City and Guilds (Engineering) College	Diploma or Second Division Certificate in Electrical Engineering.
City and Guilds of London Institute	A Pass in the Final or Honours Grade in Electrical Engineering.
Faraday House	Diploma in Electrical Engineering.
Finsbury Technical College ..	Day Course Certificate in Electrical Engineering.
King's College	Diploma or Certificate in Electrical Engineering.
Northampton Polytechnic Institute	Four Years' Engineering Course Certificate.
University College	Diploma in Electrical Engineering.



NATIVES UNLOADING CASES OF MARCONI APPARATUS IN EAST AFRICA.

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CARRYING A MAST SECTION TO THE STATION SITE.

	Dublin.
Royal College of Science for Ireland	Diploma in Engineering.
	Edinburgh.
Heriot-Watt College	Diploma in Electrical Engineering.
	Glasgow.
Royal Technical College	Diploma in Electrical Engineering.
	Liverpool.
University	Diploma in Engineering in the Honours School of Electrical Engineering.
	Manchester.
Municipal College of Technology ..	Certificate of Technology in Electrical Engineering.
	Newcastle-upon-Tyne.
Armstrong College	Diploma in Electrical Engineering.

In addition to purely engineering work, wireless engineers, before being placed in charge of contracts, whether large or small, must have some experience of the engagement and control of labour, the transport of goods, including customs arrangements, and must possess a working knowledge of accounts and correspondence. A certain amount of experience in these matters will be obtained by the engineer while serving as assistant; nevertheless, any previous training which adds to such experience is bound to count in the long run and accelerate promotion.

To illustrate this article, we have picked at random a few photographs, taken by wireless engineers while engaged upon their work in various parts of the world. These pictures will, perhaps, help the reader to realise the skill required in superintending the construction of foreign wireless stations.

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Maritime Wireless Telegraphy

Convoys and Wireless.

It is not long since we had in the House of Commons a statement by Sir Eric Geddes showing how successful has been the convoy system. Nothing was said regarding the part played by wireless telegraphy in the elaborate organisation of this system of ocean crossing, but those acquainted with the facts would not hesitate to pay high tribute were they questioned on the subject. A writer in a recent issue of *The Daily Mail* lifted the veil a few inches when speaking of the work of the young lieutenants in charge of navigation. "'Number One,'" he says, "carried "steadily along with his 'watch,' answering the wireless messages, turning on the "signalman to flash short, concisely worded messages to consorts now and again, "and attending to the dozen and one other things that keep him busy."

It is the co-ordination of wireless and lamp or flag signals which is so valuable in the convoy system.

The telegraph guardship, with a keen young operator on watch, receives from sundry stations those orders on which so much depends.

Lamp or flag signals, with their limited range of visibility, serve for inter-communication between the ships of the convoy and, "fed" by the wireless, do everything that is required. So are the old and new combined.

Let those who think that the life of a wireless operator is one of comparative indolence remember the splendid and tireless service rendered by the "wireless men" on convoys.

With the safety of not one, but a number of vessels depending on their vigilance, with the telephones glued to their ears, ever listening for the faint signals of a coded message which may mean a complete alteration of course, they quietly serve their country in the steady defeat of the pirate craft on which the enemy so falsely banked their hopes.

A Little-Known Committee.

It may be news to many of our readers to learn that there sits at the Admiralty a "Merchant Ships' Gratuities Committee," which awards sums of money to merchant

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officers and seamen for devotion to duty when in action with enemy forces. Already to date, awards have been made to some thirty Marconi operators, whose names we hope to publish in a forthcoming issue. Besides these cases which have come to the notice of the authorities, there are, of course, numerous others, known only to those whose lips are sealed in death, and numbers more which, unwitnessed and unspoken of by the main actors, will never come to light. And yet there are still some who, if they had the power, would not allow the wireless man the status of an officer !

AMERICANS IN TRAINING.

The Allies in Europe are watching with keen interest the preparations by the United States for entry into the conflict which has now reached such a vital stage. Of the assistance to be rendered by the great Western Republic, not the least valuable will be in connection with the Mercantile Marine. Large numbers of young men are now in training for the wireless service of the U.S. Navy, both for service on warships and on merchant vessels, the radio communication of which is controlled by the Naval Authorities. The merry bluejackets shown at their studies in our photograph below are learning to send and receive wireless messages in the Philadelphia Naval Wireless School. Before long these young men will be taking an active part in the fight to defeat enemy submarines.

[Topical Press Agency.

AMERICAN NAVAL RADIO OPERATORS AT THE PHILADELPHIA NAVAL WIRELESS SCHOOL.

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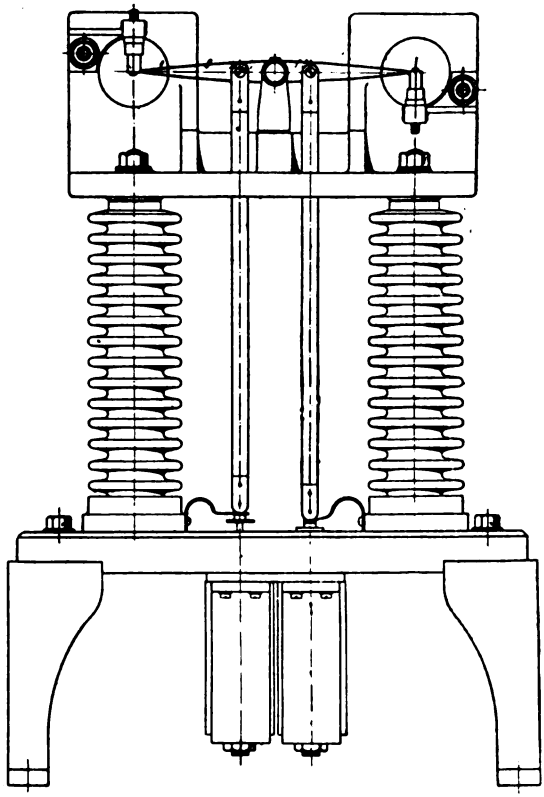

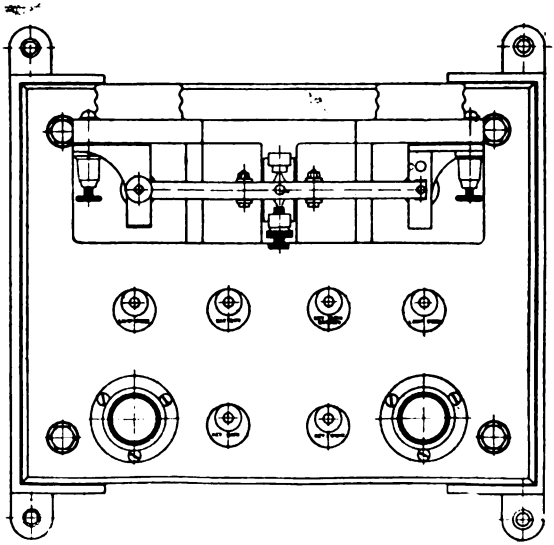

High Tension Signalling

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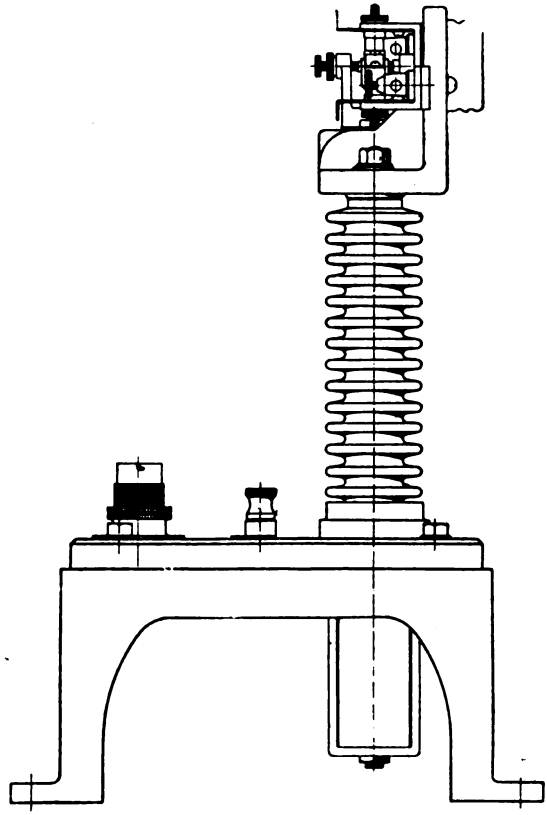

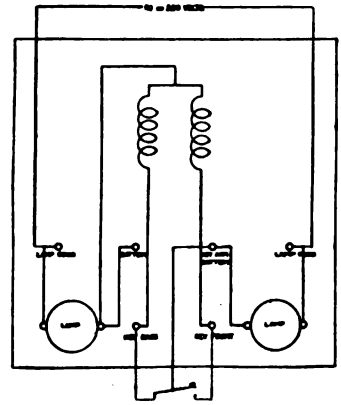

DIAGRAM OF CONNECTIONS

Switch, Plunger Type

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New Wireless Companies

Some Recent Commercial Developments

OF the many recent commercial extensions of radiotelegraphy one of the most important is that of the Pan-American Wireless Telegraph Company, which seeks to establish communication between the United States, Mexico, Central and South America.

This new company is incorporated in the State of Delaware, with offices in New York, and has acquired the right to use all patents and concessions of the English and American Marconi Companies, as well as those of the Federal Telegraph Company (owning the Poulsen-Pedersen rights in the United States), for wireless telegraphic communication between the United States and the South American Republics. The Marconi Wireless Telegraph Company of America and the English Marconi's Wireless Telegraph Company, Limited, are each interested in the new company to the extent of 40 per cent. Mr. Edward J. Nally has been elected President of the Pan-American Wireless Telegraph Company, and the Hon. John W. Griggs, Chairman of the Board. The other officers are :—Washington Dodge, of California, Vice-President ; David Sarnoff, of New York, Vice-President ; C. J. Ross, of New York, Secretary ; and John Bottomley, of New York, Treasurer. The Directors, in addition to those mentioned above, are :—James R. Sheffield, Edward W. Harden, Frank N. Waterman, all of New York, and J. L. Deahl and Edward H. Hopkins, of California.

Steps have already been taken for the immediate erection of a chain of high-power stations by which the various Republics will be brought into most intimate touch with the United States of America, and, in the words of our contemporary, the *Wireless Age*, " If better knowledge is the basis of better understanding and better " understanding of better friendship, the Americas may become more united than " ever, through the unifying influence of wireless communication."

Recent developments in France have resulted in the formation of a new Company entitled the Compagnie Générale de Télégraphie sans Fil, which was incorporated on February 5th last, with its head office in Paris. The Directors are H. Bosquet (President), Baron de la Chevreliere (Vice-President), A. L. Atthalin, M. Bloch, A. Dupont, Godfrey C. Isaacs, E. May and M. Pietri. M. Ernest Georges Sins is General Manager.

The Company, which has a capital of frs. 12,500,000, divided into 25,000 shares of frs. 500 each, has purchased all the rights and interests of La Compagnie Universelle de Télégraphie et de Téléphonie sans Fil.

Marconi's Wireless Telegraph Company, Limited, and the Compagnie des Cables Télégraphiques (known as the " P.Q." Company) are both largely interested in the new concern, which will do much to extend the use of wireless telegraphy in France, its Colonies and Protectorates.

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Correspondence

The Editor of THE WIRELESS WORLD.

DEAR SIR,—I have received from M. Blondel a letter with reference to my notice about the late Mr. Duddell. He says that he had not abandoned as hopeless the bifilar oscillograph, which Duddell improved so successfully. M. Blondel's pioneer work on oscillographs is so well known that it is only fitting to express the greatest appreciation of it which is felt by all who have experimented on methods of delineating the wave-shape of an alternating current. I regret that I have appeared to cast some reflection upon the skill with which M. Blondel developed this instrument. I may perhaps be allowed to quote the tribute which M. Blondel pays to the late Mr. Duddell :—

" Je profite de l'occasion pour payer un juste tribut de regret à votre éminent " collaborateur, M. Duddell, qui a fait dans d'autres domaines, assez d'admirables " découvertes, notamment en ce qui concerne l'arc musical, pour acquérir une gloire " durable et mondiale. On a appris en France, avec une sincère sympathie, sa morte " prématurée qui est une réelle perte pour la science."

Yours, etc.,

E. W. MARCHANT.

SIR,—With reference to the article " Some Remarks on the Morse Alphabet," by J. St. V. Pletts, appearing in the March issue, may I call attention to one or two facts of which the author is apparently unaware ?

The statement " The introduction of the earth return and central battery made the reversing of the current impossible . . . " is not wholly correct.

Up till a few months prior to the outbreak of war I had occasion, at times, to work both Single Needle and Double Plate Sounder instruments which were using an earth return and common battery. The connections admittedly were not so simple as those of the original Single Needle and Double Plate Sounder, but the functions and usage were identical. Common Battery with earth return is now used in a much wider sphere than that of Central Battery. Further, the majority of Central Battery systems of telegraphy are entirely dependent on current reversal.

Referring to signalling speed and economy, has not the writer heard of the Baudot system of telegraphy now in extensive use on very busy lines ? This system, which uses a metallic circuit, has a capacity of 2,160 letters per minute, *i.e.*, six duplex channels, each channel capable of 30 words or 180 letters per minute.

The " letters " include the alphabet and figures plus nineteen punctuation marks and working signals. It is to be noted that all signals are of equal duration.

Should the writer of the article in question require any further information, a book entitled " The Baudot Printing Telegraph System " (Whittaker and Co.), written by Mr. H. W. Pendry, explains the working of this system.

This system, of course, is not suitable for other than very busy lines, but in cases parallel to those quoted toward the end of the article, viz., less busy circuits which are required to be worked by more or less unskilled operators, the telephone has been successfully introduced.—Yours faithfully, " SEACTOC."

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Some Curves and Nomograms for Wireless Calculations (II.)

By P. BAILLIE, L.Sc.

NOTE.—*The first instalment of this article appeared in our April issue, pp. 41 et seq.*

SINCE capacity calculations, in connection with antennæ, oscillating circuits, or with any other subjects, may involve working with following formulæ:

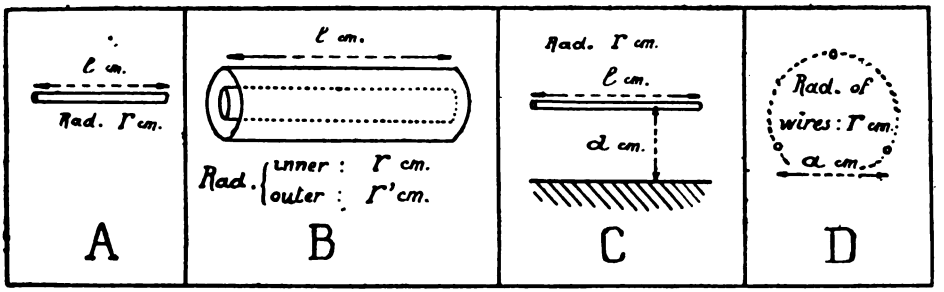

FIG. 7.

$$C = \frac{K\,l}{2\,\mathrm{Log}_e \frac{l}{r}}$$ giving capacity of an insulated cylinder (Fig. 7, *A*) . (6)

$$C = \frac{K\,l}{2\,\mathrm{Log}_e \frac{r'}{r}}$$ capacity of two concentric cylinders (Fig. 7, *B*) . . (7)

$$C = \frac{K\,l}{2\,\mathrm{Log}_e \frac{2\,d}{r}}$$ capacity of a cylinder parallel to a plane (Fig. 7, *C*) . (8)

a nomogram (Fig. 8) has been drawn which solves those three formulæ. It may be noted that it solves, also, the formula

$$C = \frac{K\,l}{18\,\mathrm{Log}_e \frac{a}{r}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

which gives the apparent capacity of a three phase air line, with the wires at the summits of an equilateral triangle.

Its use is clearly evident from small figure on nomogram (Fig. 8).

Mechanical calculations will be encountered in connection with masts and stays. It is hoped that the design of stays will be facilitated by use of curves (Fig. 10 and Fig. 11). Notations are as shown (Fig. 9). Dotted curves on Fig. 11 give values of ratio $\frac{\text{length of cable}}{a}$.

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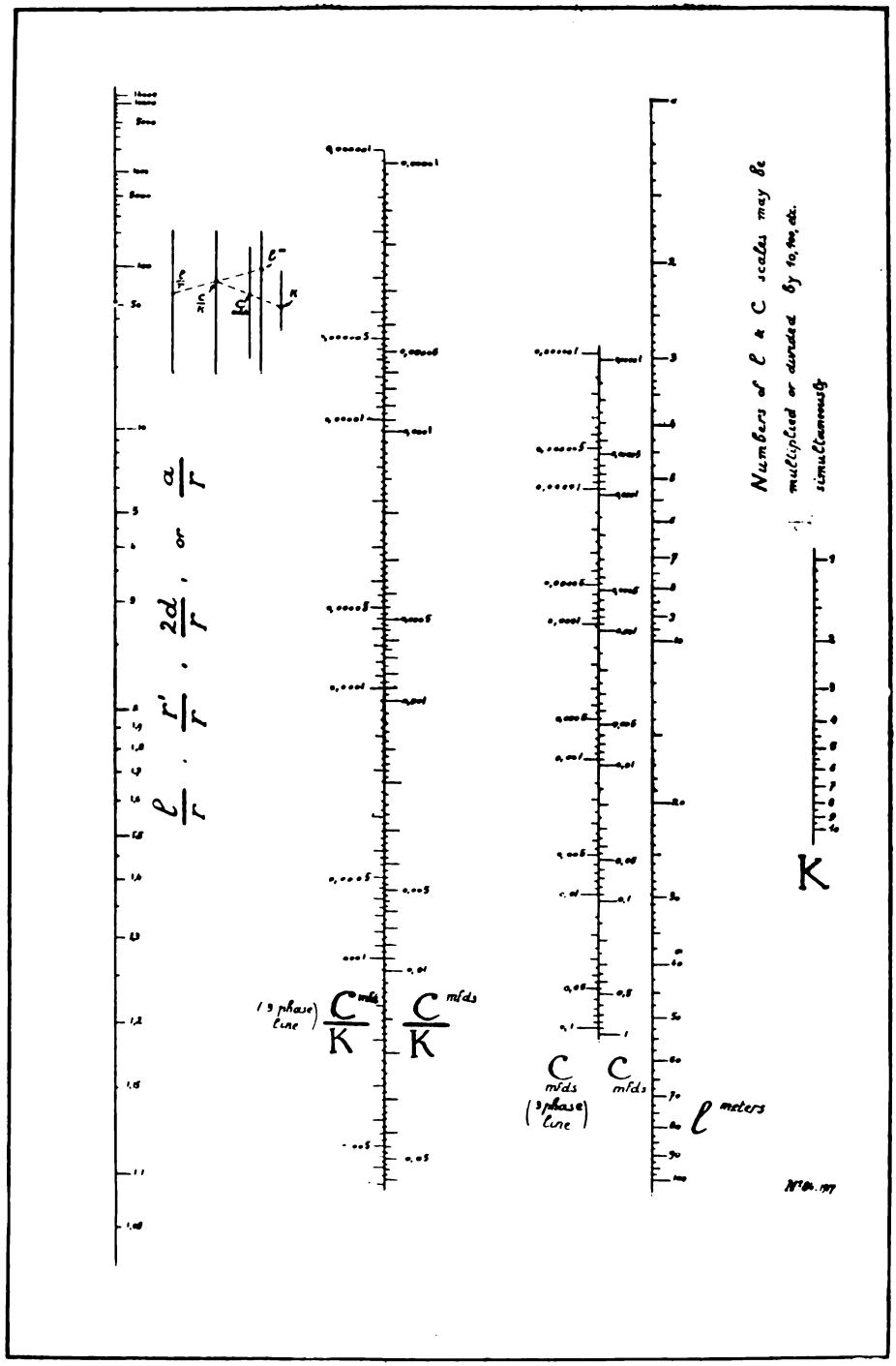
$\frac{\ell}{r}$. $\frac{r'}{r}$. $\frac{2d}{r}$, or $\frac{a}{r}$
$\frac{C}{K}$ mfds
(3 phase line)
$\frac{C}{K}$ mfds
C mfds (3 phase line)
C mfds
ℓ meters
K
Numbers of ℓ & C scales may be multiplied or divided by 10, 100, etc. simultaneously

FIG. 8.

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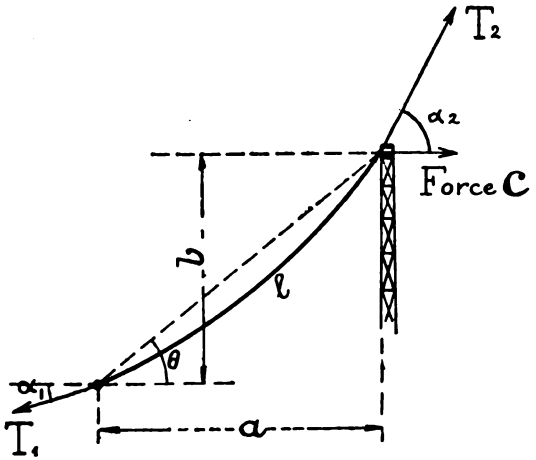

FIG. 9.

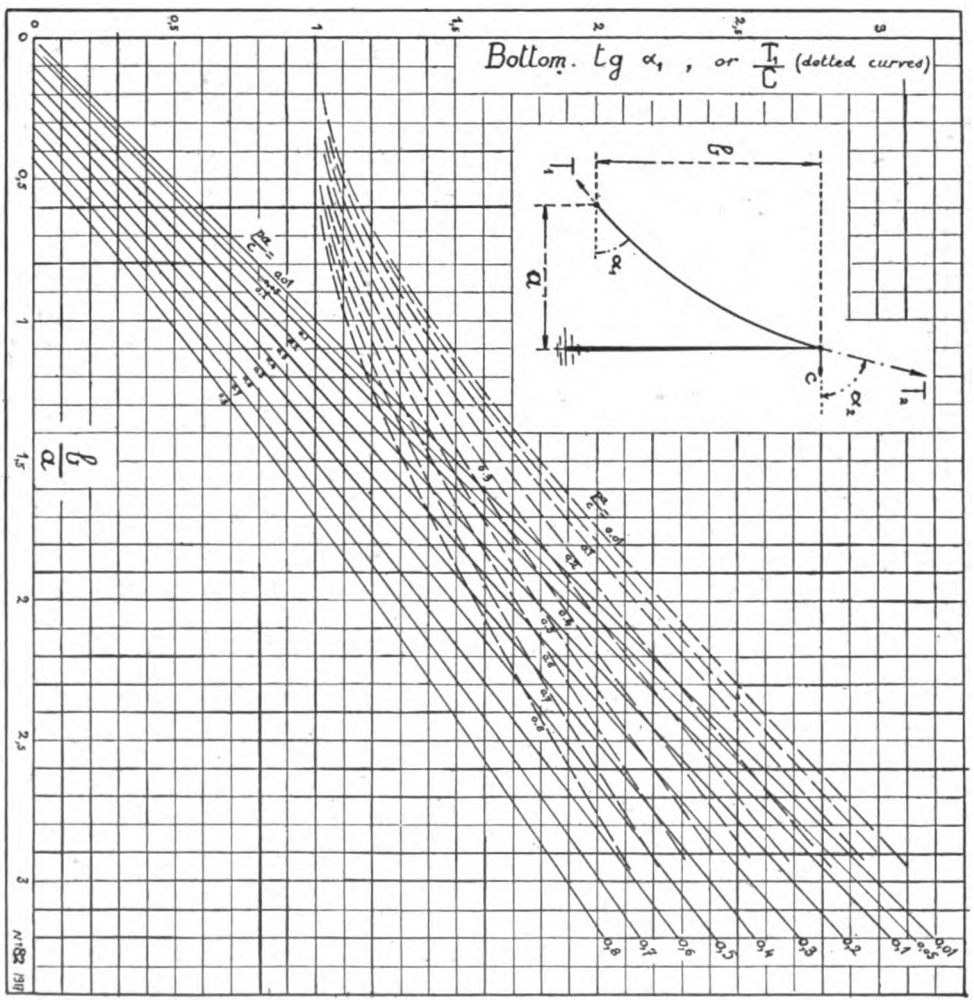

FIG. 10.

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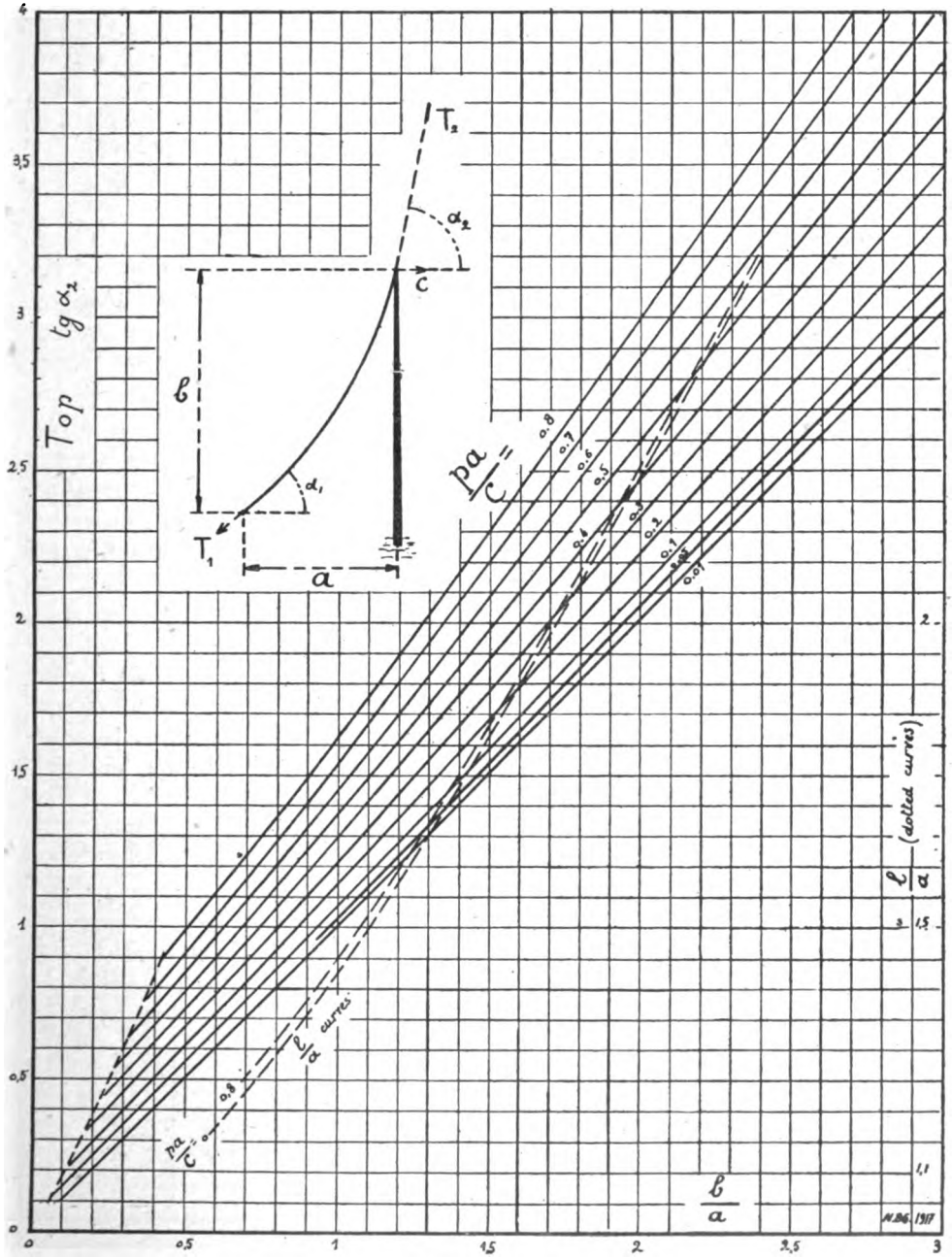

FIG. II.

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The section of the cable should be calculated (roughly and on the safe side) in order to support a strain $T=\frac{c}{\cos\theta}$.

The curves give in terms of $\frac{pa}{c}$ (p and c Kg., and a meters) the correct directions and consequently magnitude of top and bottom strains T_2 and T_1.

The inductance of antenna circuit (distributed and localised) should be calculated from values of λ and C. A nomogram has been published in this magazine * which may be of some use.

For inductance design the reader is referred to a contribution of Lieut. Bertram Hoyle,† or to curves given by M. P. R. Coursey, in *The Electrician* (September 10th, 1915). Tables are also given in the excellent book of Mr. W. H. Nottage.‡ When inductances having coupled flat coils are to be used, the reader may be referred to a paper of the author in *The Electrician*.§ Curves (Fig. 13) give the coupling coefficient in per cent. of two coaxial flat spiral coils (see Fig. 12).

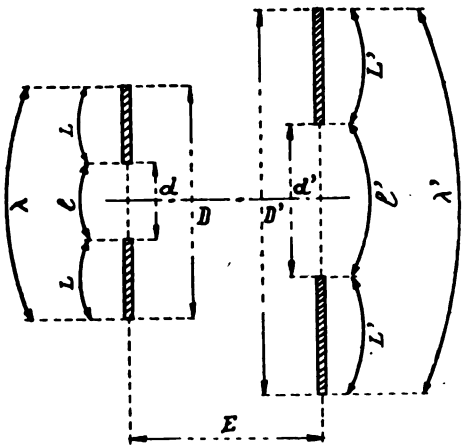

FIG. 12.

The use of these curves is as follows:

1. *Coils Wound to the Centre.* —Internal diameters = 0; external diameters, D and D'; space between coils, E. Calculate D'/E and D/E and read off K (in per cent.) from curves (Fig. 13).

2. *Coils with any Internal Diameters d and d'* (see Fig. 12).

Calculate $\frac{D}{E}$ $\frac{D'}{E}$ $\frac{d}{E}$ and $\frac{d'}{E}$, and take from curves (Fig. 2) the coupling coefficient of the various wound-to-the-centre coils, according to table below.

Effect of Coil.	On Coil.	Parameters for Curves. Fig. 13.		Obtained from Curves, Fig. 13.	Parameters for Nomogram, Fig. 14.			Obtained from Nomogram, Fig. 14.
λ	λ'	D/E	D'/E	$K(\lambda\lambda')$	$K(\lambda\lambda')$	D	D'	$R=$
l	l'	d/E	d'/E	$K(ll')$	$K(ll')$	d	d'	$S=$
λ	l'	D/E	d'/E	$K(\lambda l')$	$K(\lambda l')$	D	d'	$T=$
l	λ'	d/E	D'/E	$K(l\lambda')$	$K(l\lambda')$	d	D'	$U=$

* THE WIRELESS WORLD, "Wave-length Calculations," February 1917.

† THE WIRELESS WORLD, December 1916.

‡ *The Calculation and Measurement of Inductance and Capacity*, Wireless Press, London.

§ "The Coupling Coefficient of Coaxial Spiral Coils," *The Electrician*, September 21st and 28th, 1917.

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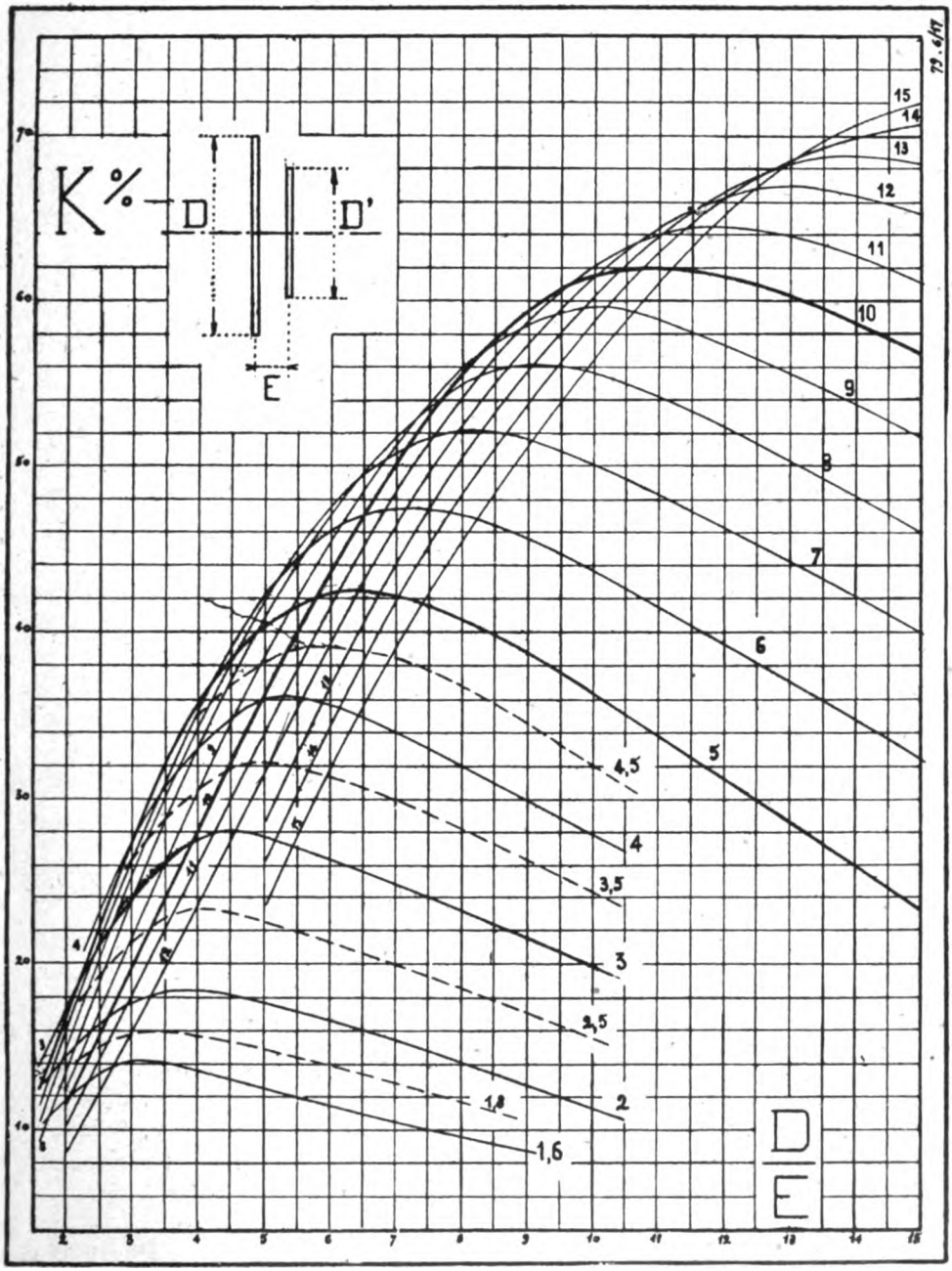

FIG. 13.

(To be continued.)

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Among the Operators

It is our sad duty, month by month, to record the deaths of the brave operators who have lost their lives at sea by enemy action and other causes in the wireless service of their country. Owing to the necessity of preventing information reaching the enemy, the names of ships and localities of action cannot be published. With the exception of Mr. G. E. Robinson, whose ship was lost in a gale, the lives of the operators mentioned this month have been sacrificed through enemy action. Both for our own part, and on behalf of our numerous readers, we extend to the parents and relatives of these young men, who so nobly uphold the "wireless tradition," the deepest sympathy in their bereavement.

* * * * * *

Mr. George Edward Robinson was born in Horbury on January 28th, 1900, and educated at St. John's School, Horbury Bridge, and Southdale Council School, Ossett. He was employed by Messrs. J. Ledbetter and Co., of Dewsbury, as a clerk, and left that firm to undergo training at the North Eastern Wireless Schools, Leeds, where he qualified, and after obtaining the P.M.G. certificate was appointed to the Marconi Company's staff in September, 1917.

* * * * * *

Born in Mains, Forfarshire, on August 29th, 1893, Mr. Norman Scott Craig was educated at Harris's Academy, Dundee. After leaving school he obtained a position with Messrs. Stewart and McDonald, Glasgow, and subsequently entered the North British Wireless Schools, Ltd., in that city for training in wireless telegraphy. On gaining the P.M.G. certificate he received an appointment in the Marconi Company in July, 1915.

* * * * * *

Mr. Robert Methven Deadman was born in Reading on June 23rd, 1900, and went to school there. Commencing his career in the office of the District Valuer, Inland Revenue, he subsequently attended the Marconi House School, and there obtained the P.M.G. certificate. Mr. Deadman's service with the Marconi Company dated from the beginning of this year.

* * * * * *

Of Irish birth, Mr. Michael Peter Sinnott was 23 years old, and came from Gorey, Co. Wexford. He received his education at Blackrock College, and Skerry's College, Dublin, and was trained at the Atlantic Wireless College, Cahirciveen, where he gained the P.M.G. certificate. Mr. Sinnott was appointed to the Marconi Company's staff on September 16th, 1917.

* * * * * *

Mr. William Harold Southcott was born in Morchard Bishop, North Devon, on April 18th, 1901. He was educated at the Elementary School there, and at Crediton Grammar School. Entering Marconi House School for training in wireless telegraphy, he gained the P.M.G. certificate, and was placed on the staff on December 9th, 1917.

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ROLL OF HONOUR

READING FROM TOP LEFT TO RIGHT: OPERATORS PINDER, ELLIS AND WARDROP; DEADMAN AND SOUTHCOTT; CRAIG AND BULL; ROBINSON AND LALLY; SMITH, SINNOTT AND STEWART.

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Dumfries was the birthplace of Mr. John Waidrop, and he was nearly 19 years of age. After receiving his education at North Kelvinside, Alan Glens School, and the University, Glasgow, he went to the North British Wireless Schools, Ltd., Glasgow, for training. When in possession of the P.M.G. certificate he was accepted by the Marconi Company, and joined the operating staff last September.

* * * * * *

Mr. William Edward Pinder, born at Salford on December 28th, 1898, was educated at the Urmston Higher Grade School, after which he was employed as draughtsman by Messrs. Royles, Ltd., Engineers, Irlam. His wireless training was received at the Marconi House School, and on receipt of the P.M.G. certificate in August, 1917, he proceeded to sea in the service of the Marconi Company.

* * * * * *

Mr. Thomas Stewart was born on July 13th, 1900, at Bury, and received his education at St. Chad's and the Technical Evening Schools. After leaving school he was employed by the Lancashire and Yorkshire Railway Company, and Messrs. Mellor, Ltd., Warth Mills, Bury, respectively, leaving the latter to take up wireless. Trained at the City School of Wireless Telegraphy, Manchester, Mr. Stewart qualified for the P.M.G. certificate, entering the Marconi Company's service in January last.

* * * * * *

Born on September 3rd, 1896, at Ballyconnell, Mr. Michael Lally was educated at Kilbeacantry, Ballyturin, and Loughcutra, and trained in wireless telegraphy at the Irish School of Telegraphy, Cork. After obtaining the P.M.G. certificate, Mr. Lally was appointed to the Marconi Company's staff on May 31st, 1917.

* * * * * *

Formerly clerk to the Professor in Civil Engineering, University of Liverpool, Mr. Henry Osborn Smith was born at St. Helens, Lancashire, on August 18th, 1899, and educated at the Higher Grade School there, and Kelvin College, Liverpool.

Greatly interested in wireless telegraphy, he took a course of training at the Liverpool Wireless Training College, and received the P.M.G. certificate. Mr. Smith entered the Marconi service in December, 1917.

* * * * * *

Mr. Charles Ellis was born on August 28th, 1899, at Heywood, and attended the Reddish Council School where he was educated. For a time he was employed by the Broadstone Spinning Company, Reddish, after which his wireless training was received at the Manchester Wireless Telegraph Training College, where he qualified for the P.M.G. certificate. Mr. Ellis was placed on the Marconi operating staff on September 16th, 1917.

* * * * * *

Mr. Jabez George Bull, a Gloucestershire man, was born at Hanham on February 15th, 1895, and received his education there and at Bristol. He was employed as a collector in the Post Office Telegraph Department at the latter city, where he learned telegraphy with a view to becoming an operator. Accepted as a student at Marconi House School, he soon qualified for the P.M.G. certificate, and was placed on the sea-going staff. Mr. Bull has been spoken of in high terms by the several commanders under whom he served since February, 1913.

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Imperial Wireless Chain Litigation

Marconi Company's Petition of Right

On March 14th a Petition of Right by Marconi's Wireless Telegraph Company Limited came before the Court. The Company claimed a Declaration that the Postmaster-General was not entitled to repudiate an agreement dated July 30th, 1913, for the erection of a chain of wireless stations.

The case, which had been expected to extend over many weeks, concluded on the third day, when the Attorney-General intervened admitting breach of contract by the Government. Mr. Justice McCardie said that the course proposed on behalf of the Crown was a right one, and the result would be that there would be declarations that the Postmaster-General was not entitled to repudiate the agreement of July 30th, 1913, and that the agreement was wrongfully repudiated by him. The suppliants were entitled to have the damages assessed by some expert to be appointed.

Of the many comments which have appeared in the Press, perhaps the best is that published under the heading of " Chapters in Wireless History " in our enterprising contemporary, *Electrical Industries*. The position is so clearly stated that we take the liberty of reprinting the article in full.

The writer remarks that it is difficult to say, at present, whether the history of wireless telegraphy in Great Britain ought to be written by, say, Dr. Erskine Murray or by William Le Queux. There is, indeed, enough material for two histories, one by the man of science and another by the author who revels in spies, plots, intrigues, secret documents, startling revelations, and all the other elements in melodrama. Most phases of the electrical industry have had a rather stormy career, but not one of them can show anything like the tempests of personalities, accusations and counter-accusations, scandals and litigation which have raged around wireless telegraphy almost since Mr. Marconi demonstrated his apparatus to the Post Office. The latest outburst is characteristic in the suddenness with which it rose and the violence it displayed. During the hearing of the case for breach of contract brought by the Marconi Company against the Post Office a letter was read from two directors of the Telefunken Company to Mr. Godfrey Isaacs referring to an alleged offer by Sir Charles Hobhouse (then Postmaster-General) and Sir Henry Norman of support for Telefunken competition with the Marconi Company in Great Britain. Sir Charles made a speech in Parliament denying the statements in the letter ; Mr. Isaacs asked him to " come outside " to settle the question ; and Mr. Isaacs has now obtained a writ against Sir Charles for libel.

Apart from this case, we are surprised that anybody should be indignant over the accusation that he sought to introduce foreign competition against a British " monopoly." Only since August, 1914, has such conduct become heinous. Previous to that date it was the correct thing. During 1912, when the Post Office was arranging for the erection of the Imperial " wireless chain," the absence of any effective

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competition with the Marconi Company was a serious embarrassment to the Government. In the House of Commons the contract was denounced by Mr. Arnold White as "a sinister precedent," and member after member treated the negotiations as a friendly conspiracy between the Post Office and the Marconi Company. Mr. Samuel (then Postmaster-General) proved that he had beaten the Marconi Company down on many points; he had also checked the Marconi prices with the aid of a technical committee, and he had secured terms much below those which the German Government had granted to the Telefunken Company in similar circumstances. In spite of his explanations, a Select Committee was formed to examine the agreement, and many precious months were wasted in talk which left the situation very much as it was before. "The Marconi Scandal" was of infinitely more importance to Members of Parliament than the development of wireless telegraphy on an Imperial basis. These were the days when the anti-Semites revelled in the alleged stockbroking sins of Samuel and Isaacs and the brother of Isaacs.

With that irrelevant aspect of wireless telegraphy in Great Britain we do not propose to deal. Practical interest lies in the organised attempt made to discourage a British industry. The number of Members of Parliament who took a sympathetic interest in the Poulsen Goldschmidt and Telefunken systems was extraordinary. In October, 1912, Sir Henry Norman quoted with approval a remark to the effect that "after all, wireless installation is only a superior kind of gas fitting," and he denounced the agreement as constituting a Marconi monopoly. In December, 1912, when giving evidence before the Marconi Enquiry, he returned to the subject. "A commercial company," he said, "receiving from the British Government a "concession giving it the British Empire for its chief field of operations would "thereby acquire so much prestige and such vast opportunities that wireless "inventors would be almost compelled to come to it hat in hand, and if their "inventions were refused they would be gravely discouraged." He also repeated a suggestion that the Postmaster-General should use his statutory powers to get everything he needed from the Marconi Company without further payment.

From these extracts we may pass to the letter which was received by Mr. Godfrey Isaacs on July 21st, 1914, from two directors of the Telefunken Company :—

"Re Lepel.—As I told you upon the occasion of our meeting in Paris, when the "Postmaster-General and Sir Henry Norman were in Berlin they made an offer to "the Telefunken that they should start in keen competition in England with the "Wireless Company and that we could rely upon the Government's support provided "that the Telefunken would make offers lower than the Wireless. Having regard to "the arrangements which we have made, we told these gentlemen that we are "naturally competing with the Wireless in England, and that it would be practi-"cally impossible for us to make lower offers than the Wireless Company, having "regard to the fact that our expenses on account of licences, etc., would be higher "than those of the Wireless Company, besides which our patent position in England "was uncertain.

"From this Sir Henry Norman formed the opinion that there would be little "question of relying upon the Telefunken Company as a competitor of the Wireless

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"in England, and he therefore approached Herr von Lepel with the object of " encouraging him to form an English company and to obtain for him financial " assistance. With this object amongst others, we understand that these gentlemen " are endeavouring to obtain financial support from Mr. Beit. We did not want " to fail in giving you this information, and remain yours faithfully, GESELLSCHAFT " FUR DRAHTLOSE, TELEGRAPHIE m.b.h.—BREDOW, SOLFF.—P.S.—Mr. Hird knows ' more."

It is worth noting the terms in which Sir Henry Norman traverses this account in a letter to Sir Charles Hobhouse :—" It is of course ridiculously untrue, so far as " I know, for anyone to say that during our visit to Berlin you tried to induce the " Telefunken Company or Lepel, or anybody to start a wireless factory in England " in competition with the Marconi Company."

Nothing is said in the Telefunken letter about starting a factory, and there was no need for the Telefunken Company to do any such thing in order to do what so many Members of Parliament were anxious to see done—undercut the Marconi Company. The personal aspect of this dispute can be settled only in open court—where it will now be settled—but the Telefunken Company might have been forgiven if it treated Sir Henry Norman's visit as an invitation to come over and help the anti-monopolists. There was plenty of evidence that help—even German help—would be welcome. As we remarked in August, 1913, " the manner in which " certain newspapers have continued to advertise foreign wireless telegraph systems " and throw contempt on the Marconi Company—all, of course, without the slightest " party bias and with a pure desire to serve the public interests—has been par- " ticularly nauseating. . . . From start to finish . . . the Marconi case has proved " that a British company need not expect the slightest consideration at the hands of " Parliament."

Speaking at the subsequent annual general meeting of the company, Mr. Marconi said :—" I cannot learn of an instance where Parliament has ever before " had recourse to the sledge-hammer power which it possesses of placing a private " enterprise in such a position that its only alternative to making further con- " cessions demanded of it would be the imperilling of its reputation and business " throughout the world."

Among the tangled uncertainties of wireless history there is one indubitable certainty. German wireless telegraph interests were not indifferent to the way in which British patriots were playing the German game. Knowing the German as we now know him one can be sure that every assistance was given to the anti-Marconi agitation. Long before the question of the Imperial contract came up, it was notorious that Germany was jealous of British pre-eminence in wireless telegraphy. The visits of Count Arco to Marconi demonstrations should not be forgotten nor his subsequent attempts to make piratical use of the information he secured. When the Marconi Company began to organise a successful maritime service, the German Government engineered the International Radiotelegraphic Convention, and used all its black arts of diplomacy to give the German wireless telegraph companies the full benefit of British enterprise. At every stage of the proceedings the Marconi Company had to fight, and fight hard, for elementary

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rights. At no stage in its history did it enjoy anything within a thousand miles of the support which the German Government gave to companies which had, in spite of the vaunted superiority of German science and organisation, failed to draw level with the achievements of the Marconi Company. We take some credit for the fact that from the earliest days of commercial wireless telegraphy we were almost alone among our trade and other contemporaries in advocating the policy which is now a commonplace—the policy of fostering and safeguarding British enterprise. It is now easy for even the most obtuse Member of Parliament to see that if British wireless telegraphy had been given a fraction of the support which Germany lent to its inventors and manufacturers, the development of facilities for communication of immense strategical value would have been much more advanced in August, 1914, than it was in fact. But in those earlier days the representatives of the people seemed to be much more concerned in hampering a vital British industry and in encouraging German competition with a view to preventing that industry from being demoralised by prosperity. These broad aspects of wireless history are worth recalling, if only because there are still some strangely-constituted people who regard a successful British enterprise as a menace to the public and the Empire at large.

The *Investors' Review*, writing on the case in its issue for March 23rd, says :—
"Nothing could exceed the disagreeableness excited in the people's minds by the "Marconi suit against the Postmaster-General. So bad apparently was the case "of the Government, that it ought never to have been fought. If the Marconi "Company was right—as the withdrawal of the Law Officers of the Crown after "the hearing had gone on for several days seems to prove—then to whose stupidity "do we owe the raking up of this scandal into the people's sight? The Marconi "Company alleged breach of contract and claim damages. Its contention and "claim have been proved well founded."

Share Market Report

LONDON, *April 11th*, 1918.

BUSINESS in the industrial market has been very restricted during the past month. Prices in the shares of the Marconi group have remained steady. The shares of the International Marine show a marked firmness. The very satisfactory report of the American Company was well received. The announcement of the formation of the new Pan-American Company, linking up the United States and dependencies with the Southern States, created a most favourable impression, and should greatly enhance the value of the present company. The closing prices as we go to press are :—Marconi Ordinary, £3 2s. 6d. ; Marconi Preference, £2 12s. 6d. ; Marconi International Marine, £2 8s. 9d. ; Canadian Marconi, 10s. ; American Marconi, £1 3s. ; Spanish and General, 8s. 6d.

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Instructional Article

NEW SERIES (No. 2).

EDITORIAL NOTE.—Below we give the second of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

MATTER, FORCE, AND MOTION.

GENERAL PROPERTIES OF MATTER.

MOST people are familiar with the doctrine of the indestructibility of matter, or, as it is also called, the conservation of matter. It states that we can neither create nor destroy matter, the sum total of which remains invariable. That we can change the *state* of matter is a fact of everyday experience which scarcely needs illustration. When we evaporate pure water it appears to be destroyed, but every schoolboy knows that by condensing its steam he can regain practically the whole amount of water with which the experiment began. Again, if water is subjected to the action of an electric current its bulk diminishes but invisible gases are formed which can be made to re-combine to form water. The burnt or consumed portions of a piece of coal, plus the ashes left behind, weigh as much as the coal itself, and many quantitative experiments have shown that we cannot increase or reduce the total quantity of matter. It is this test which is applied by the physical scientist to ascertain whether a phenomenon has real existence; if it is conserved it is a fundamental reality; if it is not conserved it has not physical existence. As we shall see later, energy also stands the test and takes its place as one of the only two things considered by *physical* science to be entities. Light and heat are produced during the burning of a piece of coal but finally disappear, leaving us with ashes, water vapour, certain gases, unconsumed carbon and perhaps sulphur and several other products. All of these added together will account for the weight of matter we began with, so that the loss of the light and heat makes no difference to the *amount* of matter though it has something to do with its change of *form*. The result of the fire is that we have destroyed that particular *combination* of atoms which is called coal, but we have not destroyed any atoms. If, however, it were possible to take the ashes and gases and reconstitute the piece of coal, we should find that we require the *energy* of the light and heat (though not necessarily in those forms) for this was essential to the making of the coal in the first instance.

Weight.—It was stated in the last article that a property of matter which distinguishes it from all else is that it occupies space. Another of its properties, equally

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characteristic and more important for the student of physics, is Weight. Practically everyone knows what Weight is although not everyone can define it, and as in science we have to be quite clear and agreed about our definitions it is necessary to define certain familiar phenomena with a degree of precision which may appear to be somewhat overdone. As a matter of fact, in this instance we are confronted not with something simple but with a mystery, fundamental and inexplicable, which we can only refer to a *cause*, leaving the state of knowledge much as it was before. Hence Weight is described as the **attraction between the earth and all matter.** The particular *name* given to this attraction is the Force of Gravity, a phrase which introduces another term requiring explanation, for we have not yet dealt with the idea of Force. Gravity tends to pull matter downwards in a vertical direction towards the centre of the earth, and it is this pull which we experience when we lift a body. The attraction between the earth and a mass of matter is mutual—that is, the force of attraction acts in both directions at once, so that the earth also *tends* to move towards the mass of matter. The reason why it is the smaller body only which appears to move is that no movement of the whole earth would be observed by us, for we do not even notice, save by the apparent variation of the positions of bodies outside it, the diurnal motion of the earth or its orbital movement round the sun.

The weight of a body is not a constant quantity inasmuch as it varies for different parts of the world. As the earth is slightly flattened at the poles a body when in those regions will be nearer to the earth's centre than it would be at the equator, and consequently* will weigh more within the Arctic Circle than in Equatorial Africa.

Mass.—The **mass** of a body is said to be the quantity of matter it contains, and although this definition seems somewhat vague and unsatisfying it indicates one important truth very clearly—namely, that mass, in contradistinction to weight, is a constant quantity for any given body. A block of iron weighing a ton may weigh less if taken to another latitude, but it will contain just as much matter in one place as in any other ; in fact, were it possible to remove it from the influence of the earth and all other bodies its *mass* would not be altered at all, whereas its *weight* would disappear.

For most practical purposes mass and weight may be regarded as the same when we are dealing with any one part of the world. This will be clearer to the student after he has read about the practical units of mass and weight, but he must not forget that **Weight is a force but Mass is a quantity of matter.**

Inertia.—Every mass possesses a property, inherent in even its tiniest particles and quite as mysterious as Weight, to which is given the name Inertia. **The Inertia of a body is that property of it which opposes its movement and which, once the movement has begun, opposes its acceleration,† retardation, and cessation.** We know very little more than this about inertia and to attempt to explain what it is and how it works would be as futile as to try and explain Time. The *effects* of Inertia are so far-reaching and important that we shall return to the subject again after certain considerations of Force, Motion, and Energy.

* Because the force of attraction will be greater.

† Acceleration is here used in the ordinary sense, meaning increase of speed.

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FORCE.

Two bodies, one charged negatively * and the other positively,* either move towards each other or tend to do so. If these bodies are both charged positively they either move away from each other or tend to do so, and a similar statement applies if they are both charged negatively. *Neither of the bodies has the innate power to perform these movements*, such power being possessed only by *living* bodies, so that it is not correct to consider their movement as originating within them. Nor would it be strictly accurate to say that they exert attractive or repulsive force for this would seem to endow them with *will*, or to imply that each possesses *of itself* the power to attract and repel, an implication quite contrary to facts. We give the name of Force to *that which causes* them to move or to tend to move. It should be understood, however, that Force is not a *thing* such as Matter or Energy, for, unlike these, it is not conserved. Causes such as those to which we give the name of Force can be both created and destroyed; hence Force has no objective existence. It is clear that we can bring into play a certain set of conditions as a result of which two bodies will move together, or will, in common parlance, exert attractive force; but it is equally obvious that we can eliminate that force (or cause of movement) by altering the conditions. In other words, we can destroy the attractive force. It is perhaps best to consider bodies as being acted upon by causes (called Forces, if we please) as a result of which there is a change of motion. In the case of a body starting from a position of rest and moving towards another there is a change from the motion of its particles to a combined motion—*i.e.*, that of its particles and the motion of translation of the whole body.

If while the body is moving in a straight line another set of conditions arises, it may deviate from its direction along that line. Here, again, we must assume a cause (which we may call Force) responsible for the deviation, so that we can add to our first definition the statement that that which we call Force prevents or tends to prevent a body from moving uniformly in a straight line.

Certain conditions, arising whilst a body is moving at a uniform rate in a straight line, may result in a decrease or increase of the rate of movement. The *cause* of this variation of uniform motion is termed a Force.

Combining these ideas we define the cause known as Force as **that which starts or stops, or tends to start or stop uniform motion in a straight line.** In order to avoid repetition and circumlocution it is convenient to refer to the "force of attraction" or "the force exerted by a body," and so on; we can even measure "force" and agree upon an unit of "force," but it should be understood that we are only measuring the strength or degree of certain *effects* and not their *causes* which have no physical existence. When we speak of a "force of one dyne" we are merely referring, in terms of Time, Space and Mass, to what some *cause* can do or tend to bring about—that is, to give a *mass* of one *gram* an acceleration of one *centimetre* per *second* per *second*.

A Force is a *vector* quantity, for to describe it we have to specify: (1) its magnitude, (2) its direction—that is, the direction in which it acts—(3) its sense—that is,

* It is assumed that the student understands these terms as a result of his work on the subject of electricity.

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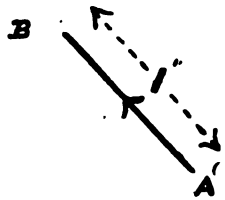

FIG. 10.

whether it acts towards or away from a given point. Fig. 10 represents a force of 10 dynes (scale: 10 dynes to 1 in.). The length of the line gives the *magnitude* of the force; the direction of the line—*i.e.*, north-westerly—gives the *direction* along which it acts, and the arrow indicates its *sense*, which in this case is away from the point **A**. By the **Addition of Vectors** (see last article) we can determine the resultant of a number of forces acting at a point. For a development of this subject let the student look up the Parallelogram of Forces in a book on Mathematics.

Notes on Units.—Any measurement of a physical quantity has to be expressed in terms of its unit, the expression taking the form of some number followed by the name of the unit—*e.g.*, five seconds. The general form of any measurement can be written nU, n being a number and U an unit.

As a foundation on which to erect a working unitary system units of Length, Mass and Time have been agreed upon and are called fundamental units, not only because nearly all physical quantities are defined in terms of them, but because the ideas of Length, Mass, and Time are fundamental.

The English **unit of length** is the **yard,** that of the French being the **metre.** Taking the first case, if we call the unit L then any length can be written nL. Thus one inch equals $\frac{1}{36}$ L and two yards equal $2L$; but L may stand for *any* agreed unit of length, such as an inch, a mile, or a centimetre, and, therefore, it obviously represents only the **magnitude** or **dimensions** of the particular unit employed. Thus 39·37 L (**inches**) $=1L$ (**metres**) $=100L$ (**centimetres**) $=1{,}000$ L (**millimetres**). The **dimensional unit of Length** is $[L]$.

The **Area** of a square with sides of unit length can be written L^2, because to find its area we square the length of a side. L^2 expresses the **dimensions of unit Area.** If the sides of a rectangle measure a units and b units respectively, its area is clearly $(aL \times bL) = abL^2$—*e.g.*, Consider a rectangle with sides 4 in. and 5 in. Then Area $= (4L_{inches} \times 5L_{inches}) = 20L^2$—that is, 20 square inches. In the same way the **dimensions of unit Volume** are L^3.

The fundamental unit of **Time** is the *mean* solar day, its **dimensions** being denoted by **[T]**.

The English unit of **Mass** is called the **standard pound,** which is the mass of a certain piece of platinum in the possession of the authorities. For most practical purposes this can be taken as the unit of **Weight,** as previously explained; but the distinction exists that this only holds good provided only one *place* is considered. Weight is *proportional* to mass and equal masses *in the same place* have equal weights.

The French unit of **mass** is the **kilogramme.**

The **dimensional** unit of Mass is **[M]**.

It is customary to distinguish dimensional units by enclosing them in brackets—*e.g.* **[T]**, **[L]**.

Centimetre-Gram-Second (or C.G.S.) Units.—For the purposes of physics it is the general custom to employ the **centimetre, gram,** and **second** as the respective units of length, mass, and time. Calculation in these units is very simple and the

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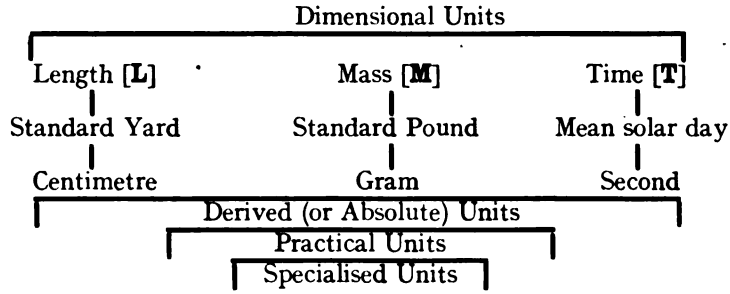
units themselves are of a convenient size. Just as the mile is more appropriate for the use of the geographer and the ton more practicable for the civil engineer, than smaller measurements, so the centimetre and gram better convey ideas of the distances and masses most commonly investigated in physics. It would be absurd to describe the length of a spark-gap as some fraction of a mile and even the description of a four-millimetre gap as a fraction of a yard would not at once be plain.

The units derived from these fundamental ones are called **absolute units.** Although the centimetre, gram, and second are of a convenient size, some of the derived units are either too large or too small. To meet this difficulty **practical units** have been agreed upon. For example, the **practical** unit of capacity, the Farad, is equal to a thousand-millionth part of the **absolute** unit, and even this is too large; hence we generally use the **microfarad,** which is a millionth of a farad. (1 mfd. $=10^{-15}$ absolute units of capacity).

Absolute C.G.S. Units.—Length = 1 centimetre (cm.).
Area = 1 square centimetre.
Volume = 1 cubic centimetre (1 c.c.).
Mass = 1 gram (1 grm.).
Time = 1 second.
Force = 1 dyne.

Other units will be given and explained as the various physical quantities are considered.



Force (continued).—The foregoing section on units was interpolated in order to clear the way to a fuller treatment of Force. The C.G.S. unit of Force has been referred to as the **dyne,** to explain which we must here introduce the ideas of Velocity and Acceleration.

Velocity.—This may be defined as the **rate at which change of position takes place in a given direction,** and should not be confused with **speed,** which is simply rate of movement irrespective of direction. Velocity may be either **constant** or **variable,** terms which need no explanation. It may occur to the reader that in many common instances, such as the movement of a train, the velocity is sometimes constant and at other times variable. During, say, the first and last ten minutes

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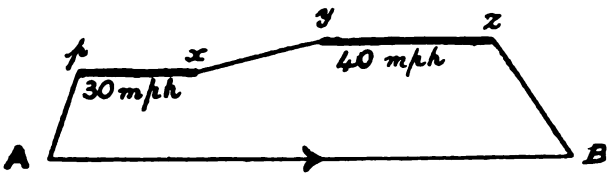

60 miles / 2 hours } Average velocity, 30 m.p.h.

FIG. II.

of a journey the velocity of a train will vary because the latter cannot start from a position of rest at its maximum velocity, and in order to stop (without being wrecked) it must gradually slow down. Fig. II represents graphically (but not to scale) the various velocities attained by a train whilst travelling from **A** to **B**. The **thin, sloping** lines show those portions of the journey during which the velocity is changing, and the **thick** lines represent the portions in which the velocity is constant. Starting from **A** the velocity gradually increases from zero to 30 miles per hour at **p** and remains at that value until the point **x** is reached, when it again increases until at **y** it is 40 miles per hour. This velocity is maintained as far as **z**, where it begins to decrease for the stoppage at **B**. The **direction** is uniform from **A** to **B**, and although the velocity, considering the journey as a whole, is variable, yet from **p** to **x** and from **y** to **z** it is constant. As the train takes two hours to travel 60 miles the **average velocity** is 30 miles per hour, but over the distances **px** and **yz** its velocity is constant and measurable by dividing the distance travelled by the time taken.

$$v = \textbf{Uniform Velocity} = \frac{l}{t}.$$

The distance travelled in unit time measures the velocity of a point moving with uniform velocity. Unit time being the **second**, v will be centimetres, feet, or metres per second according to how l is measured.

Example.—A point moves over a distance of 100 cms. in a uniform direction at a constant velocity in 10 seconds. Its velocity at any instant is found by the formula $v = \frac{l}{t}$; l in this case is 100 **cms.** and t is 10 **seconds.** Therefore, v is 10 **cms. per second**—that is to say, the point moves through a distance of 10 cms. in unit time.

The dimensions of unit velocity are written $\frac{[L]}{[T]}$ or $[LT^{-1}]$; **the C.G.S. unit of velocity is 1 cm. per second.**

(To be continued.)

Changes of Address

THE Offices of the Wireless Press Inc, New York, have been removed from 42, Broad Street, to 25, Elm Street; and the offices of Superintendent E. T. Edwards from 25, Elm Street, to 42, Broad Street, New York. These changes make it possible to enlarge the Marconi School of Instruction, to meet war conditions.

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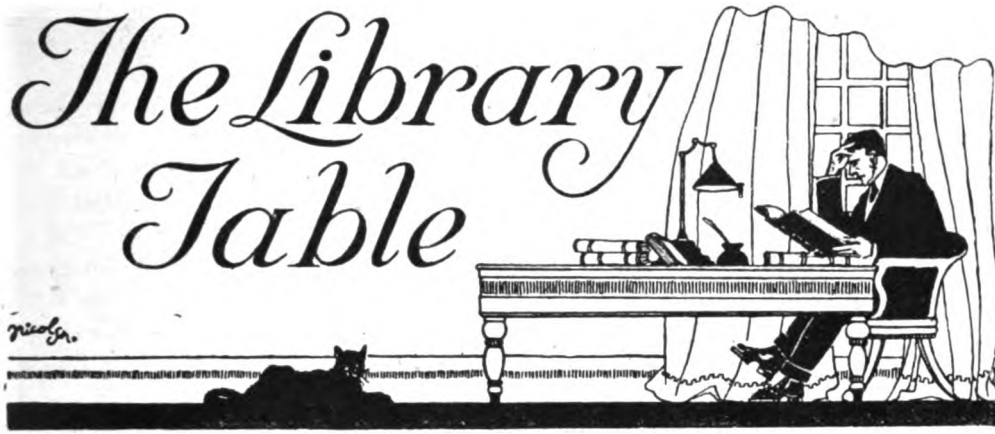
The Library Table



"THE YEAR-BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1918." *Price 6s. net.*

The expansion of an industry may frequently be judged by the literature which gathers round it, and the recent appearance of *The Year Book of Wireless Telegraphy and Telephony* for 1918 comes as a timely reminder of the expansion of this world-wide science. Not inaptly does the writer of one of the special articles quote the words of Emerson concerning a man "who builded better than he knew" and apply them to Marconi.

It is no small boon to those whose daily avocations bring them into contact with wireless to have at their elbow a volume which contains all the current legislation on the subject, in over one hundred different countries and their colonies, translated into English from the various languages in which the laws were originally promulgated. This section has been very nearly doubled since last year, whilst we find included for the first time some interesting and useful summaries of earlier legislation and present organisation affecting wireless telegraphy in the different countries.

The section devoted to tabular information concerning *Land and Ships' Stations* records the "Call Letters" and general particulars of wireless installations all over the world. We note that the enemy vessels interned at the beginning of the struggle, and taken over by the various governments who declared war upon the Central Powers, figure in these lists under the new names which have been assigned them.

The stress of war has a marked tendency to press harder and harder every year upon those engaged in useful scientific and industrial work; but—in the face of all difficulties—the *Wireless Year Book* for 1918 shows continual improvement over its predecessors instead of deterioration. All wireless men will learn with satisfaction that Dr. J. Ambrose Fleming, who has contributed special original articles to every issue of the *Wireless Year Book* since its initiation in 1913, is still able to maintain continuity in this respect. His article on "*Waves in Water, Air, Earth and Æther*" fully maintains the high standard we have learned to expect from this distinguished scientist. Amongst the new items likely to prove of the greatest practical assistance to wireless workers we may call particular attention to the

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inclusion of a series of analytical notes on the "*Valve Patents Published During 1917.*"

Dr. N. W. McLachlan's essay on "*The Magnetic Behaviour of Iron in Alternating Fields of Radio Frequency*" and that on "*The Energy Transmission in Wireless Telegraphy*" contributed by the Dutch scientist, Dr. Balth. van-der-Pol, will be found to deal comprehensively with subjects which are occupying considerable attention of technical men at the present time.

An article entitled "*Wireless Possibilities*" sets forth a series of speculations upon the future of radiotelegraphy and its allied developments. Nor must we omit to mention the record (illustrated by photographs), under the title of "*Heroism,*" of the gallant deeds of wireless operators at sea during the period covered by the volume.

Every wireless enthusiast is familiar with the time and weather signals, which are radiated on fixed programmes from important stations in various parts of the world; these arrangements have in recent years attained a world-wide development, and the *Wireless Year Book* brings this fact home very strikingly in an article on "*International Time and Weather Signals.*" "*The Achievements of Wireless Telegraphy in Life-Saving at Sea*" are dealt with in a monograph which introduces the annually published list of "Timely Rescues," brought up to date.

The secretary of the United States "Institute of Radio Engineers" contributes a brief *résumé* of the way in which wireless telegraphy in the U.S.A. has been affected by America's entrance into the present world war.

The "*Useful Data*" section appears as revised for the last issue by Dr. Erskine Murray. The "*Biographical Notices*" have received numerous additional items, whilst the bibliography of the volumes and periodicals devoted to the subject displays the effects of revision and expansion. The *Wireless Map of the World*, which is bound in with the back cover, records the position of over 800 radiotelegraphic stations.

"*SECRETS OF THE SUBMARINE.*" *By Marley F. Hay. London: Skeffington & Son. 2s. 6d. net.*

The *Secrets of the Submarine* would appear to us hardly to constitute a correct title for the volume under review. It provides, indeed, a highly interesting sketch of the features common to all under-water craft, together with some consideration of the various problems connected with sub-aqueous navigation; but—very properly—reveals no secrets concerning any of the varieties of craft dealt with.

The subject itself is, however, so interesting and novel—at all events as far as its later developments are concerned—that the little book published by Messrs. Skeffington is sure to find a large reading public. We hope that this may be so; for there are many plain internal proofs of the author's expert knowledge.

Perhaps the most illuminating chapters are those which deal with the Differentiation of Types, the Elements of Design, and the Sphere of the Submarine in Naval Policy. All these subjects, it will be noted, lend themselves readily to discussion in general terms; so that their exposition remains comparatively free from the disabilities inherent in the treatment of submarine matters at the present moment.

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Mr. Hay fully sustains the claim made in his foreword, that his subject-matter is placed before the general reading public in non-technical language, a method of treatment which should enable an ordinarily educated person to form a very fair conception of what a submarine is, and how much may be expected from it.

The first item to attract the attention of wireless men is, naturally, that which affects the application of their own science to submarine practice. We find all the consideration accorded thereto by Mr. Hay on pages 57 and 58 of his volume. After a few general remarks about the superiority of wireless telegraphy over submarine bells, he goes on to state :

> Experiments have been made with various forms of telescopic and folding masts ; but a practical arrangement for mounting and dismounting the outboard part of the wireless installation, which can be operated from inside the vessel without requiring the presence of any of the crew on deck, is a problem that remains to be satisfactorily solved. Where a number of submarines are operating in conjunction, but separated by many miles, as is the case now with the German submarines operating on the coast of Great Britain, the desirability of coming to the surface, transmitting a message and disappearing again very quickly, if necessary, can easily be imagined.

When we pause for a moment to consider that every up-to-date U-boat is fitted with wireless apparatus, which constitutes one of the most important parts of its equipment, and that without this means of communication the present submarine campaign against Great Britain and her Allies would be almost impossible, such a summary treatment would hardly appear to be adequate. Of course, the exigencies of censorship preclude the publication of the most interesting particulars, but we have ourselves been able, working under the same disability, to publish in THE WIRELESS WORLD views of German under-water craft, showing pictorially more than one of the ways in which the enemy has been grappling with the problem.

As a submarine expert, and one who has devoted his whole life to the subject, Mr. Hay naturally approaches the question of "submarine antidotes" from a specialised point of view. Chapter VIII. deals exclusively with this side of the subject, and one device after the other is dismissed as ineffective. We have a general impression left, after finishing the perusal of this particular section, that the submarine is something which it is quite useless to combat ! It can cut through nets ; it can elude the observation of aeroplanes ; the shooting away of its periscopes does little more than temporary injury ; whilst the idea that one submarine can hunt another is scouted as ridiculous, save when the two craft are floating upon the surface and have, therefore, for the time being ceased to be submarines at all ! Now, in treating of this matter at the present moment we are treading upon very delicate ground ; but without going into particulars we may, at all events, enter a *caveat* against such special pleading. The submarine is vulnerable, one might almost say very vulnerable, and is becoming increasingly so every day.

Without pursuing the matter any further than this, we would like to point out to readers that we can recommend them strongly to seize an early opportunity of perusing Mr. Hay's volume ; but at the same time advise them not to forget the point of view from which he approaches his subject.

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Marconi Companies' Benevolent Fund

Annual Meeting at Marconi House

THE annual meeting of the Marconi Companies' Benevolent Fund was held in the Board Room at Marconi House on April 3rd last, Mr. Godfrey C. Isaacs taking the chair. After the Secretary had read the notice convening the meeting, the annual report of the Committee of Management for the twelve months ending December 31st, 1917, was presented.

The sum of £812 2s. 6d. is carried forward to the current year, an increase during the year of £416 4s. 9d.

The Committee regret to report the death of 17 members. The amount payable by the North British & Mercantile Insurance Company in respect of the life assurance of the foregoing members was £1,960, making a total of £4,300 since the inception of the fund.

After the adoption of the Report the Chairman explained that the fund was growing, and would continue to grow from year to year under the conditions set forth in the constitution of the fund. The companies have provided, and will continue to provide, for all cases of temporary disablement, therefore the main object of the Benevolent Fund should be to provide for those cases where a man by accident or infirmity cannot continue in his employment and subscribe to the fund until the normal retiring age of 60. The idea should be to compensate for the difference between the pension which would be given at the time of such incapacity and that which the pension would be at maturity—viz., at the age of 60 years. The chairman was careful to point out that this was only his own personal view, and that he would like to hear any other views which members might have.

No other views being expressed the suggestion was adopted unanimously.

Institute of Radio Engineers

Temporary Suspension of Activities

OWING to conditions brought about by the war, it has been decided to suspend the meetings of the Institute of Radio Engineers, except on special occasions. Among other difficulties, that of securing new papers with regularity is perhaps the most prominent. All interested in wireless telegraphy will look forward with pleasurable anticipation to the resumption of normal conditions by this thriving society, to which the radio world owes so much.

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THE AMERICAN ARMY.

Officers and men of the U.S.A. force are also adopting Pelmanism—urged to it by what they have seen and heard of its value at the Front.

Business men are achieving what were heretofore regarded as "impossible" by the aid of those famous "little grey books" in which the principles of Pelmanism are so interestingly explained.

Businesses have been rapidly doubled and trebled and incomes enlarged in proportion by those who have been quick to realise what "Pelmanise" means to an enterprising and ambitious worker

Clerks, salesmen, typists, shopkeepers are, similarly, finding the study of "the little grey book" leads with certainty to bigger salaries and turnover. The Pelman Institute has received thousands of letters reporting increases of salary up to 100 per cent., 200 per cent., and, in a few cases, 300 per cent and more.

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"I thought Pelmanism was quackery," writes Sir James Yoxall, M.P. "Now I wish I had taken it up when I heard of it first."

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Truth says, after investigating the records of Pelman students: "Not one has expressed dissatisfaction. . . . On the other hand, there are very many who have found the results exceed their most sanguine expectations. . . . **If the full significance of the facts set forth were fully recognised, the doors of the Pelman Institute would be literally besieged by those anxious to plant their feet firmly on the road to success**" (**Truth**).

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Personal Notes

Lady Student's Success.

Miss Kathleen M. Videon, of Skelton, has recently obtained a Postmaster-General's First-Class Certificate of Proficiency at the Rutherford Technical College Wireless School, Newcastle-on-Tyne, and is at present training as a mechanical inspector of wireless telegraph apparatus at the Regent Street Polytechnic, London.

Presentation.

Mr. W. W. Inder, manager and chief instructor of the Scottish Wireless College, Aberdeen, and Mr. D. M'Kay, assistant instructor, were recently presented by the students at the school with a handsome silver-mounted pocket book and a tobacco pouch and pipe respectively, in token of esteem.

Obituary.

We deeply regret to announce the death of Captain W. H. Payne, of Amalgamated Wireless (Australasia), Limited, who fell a victim to smallpox at Bagdad in December last. Captain Payne had been attached to His Majesty's Forces but a few months at the time of his death. In our June 1917 issue we published a note regarding a farewell luncheon given to this gentleman on his departure from Australia. Captain Payne, who in peace time was deputy manager, was loved and respected by all who knew him, as was evident from the sincere tributes paid to the memory of the gallant officer at a meeting held in his honour at Wireless House, Sydney, on January 7th last. The meeting opened with Chopin's March Funèbre, which was followed by a speech by Mr. E. T. Fisk, managing director, who paid a touching tribute to his late friend and colleague. Messages and telegrams of sympathy from a number of prominent people were read, and a number of other officials of the company also spoke. A message of deep sympathy from the whole of the staff was conveyed to the widow, and the proceedings terminated with the "Dead March" in *Saul*.

THE LATE CAPT. W. H. PAYNE.

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Company Notes

Report of the Directors of the Marconi Wireless Telegraph Company of America

The operations for the fiscal year show, before allowing for reserves, a net income of $780,592.44 as compared with $336,040.59 for the year 1916.

In last year's report you were told that when diplomatic relations between the United States and Germany were severed, on February 3rd, 1917, your General Manager promptly telegraphed the President of the United States, as follows:

"The Marconi Wireless Telegraph Company of America, in accordance with the Act to regulate Radio Communication, approved August thirteenth, nineteen hundred and twelve, hereby places at the disposal of the Government, for use in any emergency, its entire organisation and personnel, including its high power and coastal stations wherever situated, its manufactories, workshops and trained staff. Myself, associate officials, and staff, are subject to your orders or to the orders of any particular department of the Government which may need our services. I shall be glad to proceed to Washington for conference if you so desire."

Acknowledgment of the above was received from the President, also from the Secretary of War and the Secretary of the Navy, all of whom expressed their thanks, and their appreciation of the spirit of co-operation displayed by your company.

Following the declaration of war with the German Empire, the Director Naval Communications, on April 7th, telegraphed your company as follows:

"The President having ordered the immediate taking over by Navy Department of all radio stations including high-power stations in United States and possessions no commercial traffic whatever should be accepted for transmission *via* radio through any Atlantic and Gulf Coast radio stations. For the present radio service Pacific Coast between ship and shore, Pacific transoceanic, Alaska and Great Lakes continue, Naval control. Please cooperate."

This was followed by subsequent orders, under which no commercial traffic can be accepted by your company for transmission *via* wireless through any station, and by the taking over by the Navy Department of all of your company's coast stations, as well as its high-power stations in New Jersey, California, Hawaii and Alaska, for military purposes, The Massachusetts stations, intended for communication with Scandinavia and Russia, and now in course of construction, have likewise been commandeered by the Navy Department, and the work of completion is being pushed forward as rapidly as possible, so that they may be turned over to that department without unnecessary delay.

All these stations are operated or will be operated for governmental and public message traffic, subject to censorship, all the operating staff being enrolled in the Navy.

Reasonable rental compensation arrangements have been agreed to, based on your company's investment in certain plants and on estimated traffic earnings under normal conditions of others.

With the stoppage of its commercial telegraph traffic, your company's officers turned their attention to ways and means whereby the facilities remaining under their control might be best used for the service of their country and the benefit of the stockholders in this emergency.

Our pressing needs of the hour, briefly, were:

First: Facilities and trained experts for the manufacture of the new wireless equipment for the large number of vessels built and commandeered by the United States Shipping Board and the Navy Department.

Second: A constant supply of capable, licensed wireless operators, for service on the rapidly increasing merchant marine.

Third: Trained construction men to instal wireless apparatus on the vessels, and engineers capable of coping with the many problems of wireless communication and production.

To meet the first need, your company has built two large additions to its factory in Aldene, New Jersey, and is now engaged in

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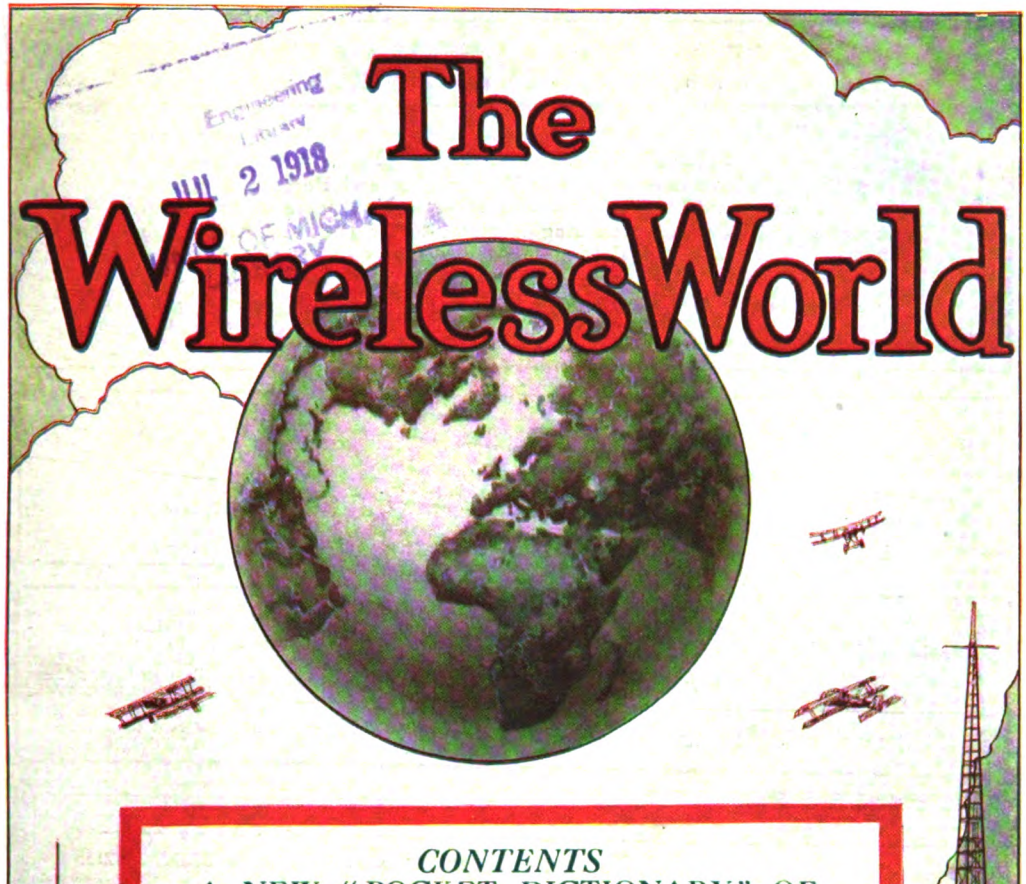

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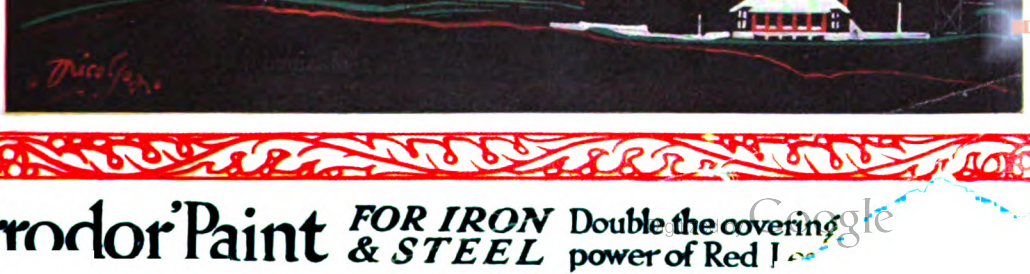

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Volume VI. No. 63. JUNE, 1918.

Reminiscences of an Operator

By W. D. OWEN

Seattle, Washington, U.S.A.

On passenger boats with anything like a claim to respectability there is invariably to be found a well-equipped shaving saloon. In fact, the "barber's shop," as it is called, is generally regarded as a rendezvous where the gentlemen gather in the mornings to swap confidences. But a tramp steamer cannot support such a luxury, consequently the members of the ship's company are compelled either to avail themselves of the services of the "lamp-trimmer," whose experience in trimming the wicks of navigation lights seems to be considered sufficient to qualify him for the job, or else to wait until reaching port.

Now some of us had tried the former plan, and had resolved in future to exercise the option. The result was that by the time we arrived at Seattle the doctor and I might have been mistaken for the band. That is why we could have been seen

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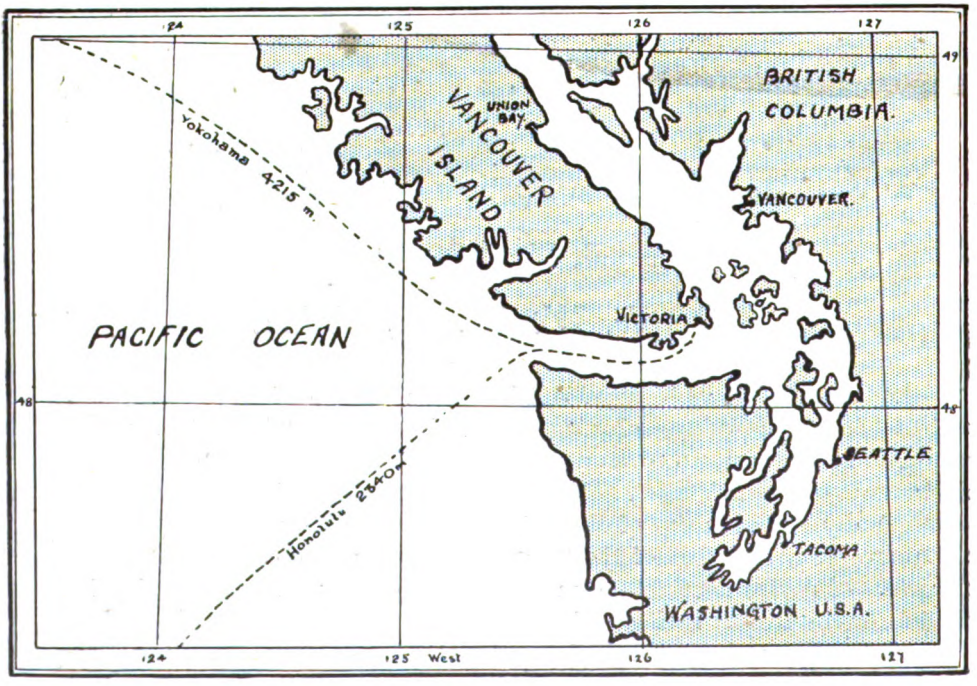
striding along Madison Street within a few minutes of tying up, with our noses towards the shop with the twirling serpent.

When we entered a white-coated gentleman detached himself from his newspaper with seeming reluctance and looked at us as a diligent business man looks at a book agent.

I asked if he'd mind cutting my hair. "Sure!" he said. "Sit down!" Well, all I could see was a row of dentists' chairs with levers, springs, wheels, pulleys and mechanical fittings too numerous to mention. So I meekly suggested that I wanted my hair cut, not my teeth drawn. He smiled a sickly, diseased sort of smile, and edged me into the nearest chair. I was too concerned about my own safety to follow the movements of the doctor; apparently he had been ordered to a distant corner of the operating room; but if he'd sounded the retreat at that moment I think I would have been out of there like a shot.

Suddenly, without warning, the chair gave a lurch and I found myself looking up into the face of the inquisitor, now bedecked with a great green eyeshade. His jaws moved sullenly and somehow or other reminded me of a tobacco factory I had once walked through. My speculations were cut short by the activities of the scissors, which flashed in the lamplight like summer lightning. Judging by the control he had over that chair he must have been a wizard. He made it twist and turn like a third-rate music-hall contortionist. Hair fell around me like grass from an overworked lawn mower, and my neck was shaved before I was aware of the nefarious intention. He then barked something at me with a tobaccoey voice the purport of which I failed to understand. Seeing, however, that he expected a



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HE WHIPPED UP THE CHAIR AND SENT ME HEAD-FIRST INTO A BASIN OF WATER.

reply I answered with true British courage, "Go ahead!" Alas, I had agreed to submit myself to "cranial massage" and a shampoo!

When I recovered consciousness I found myself on my back with my head fixed in a relic of the Spanish Inquisition, while my tormentor was pommelling me with a pneumatic riveter. At first I didn't know whether to laugh or to call for help, but before I could make up my mind either way he whipped up that chair and shot me head-first into a basin of hot water where a confederate awaited with a fire-hose. The hot spray turned into cold so rapidly that my involuntary gasp might have been a protest against either extreme of temperature. After sundry duckings I was tied up like an Indian rajah, and hot towels were laid on my face. Thus arrayed, I was beguiled once again into the haunted chair which danced to any tune the fiend in charge desired. He then shaved me with a sort of "tornado" movement—very impressive to the onlooker, I should think, but deuced awkward for the victim. It reminded me of poor old Lafayette, who shaved one of his assistants on the stage preparatory to transforming him into someone else.

I remember thinking that if this movement were set to music it would be full of those inspiriting adjectives—allegro, pizzicato, prestissimo, fortissimo, furioso, etc.

In less time than it takes to tell he finished that shave and applied hot towels, fuller's earth, sandpaper, bay rhum and Florida water in quick succession. If he thought that the perfumes would disguise the fact that he chewed tobacco I fear he was mistaken.

Meanwhile electric brushes played havoc with the remnants of my departed locks, and when at last I was jerked to my feet I found in my hand a couple of small brass tokens. One bore upon its face the imprint "$1" and the other "50 c."

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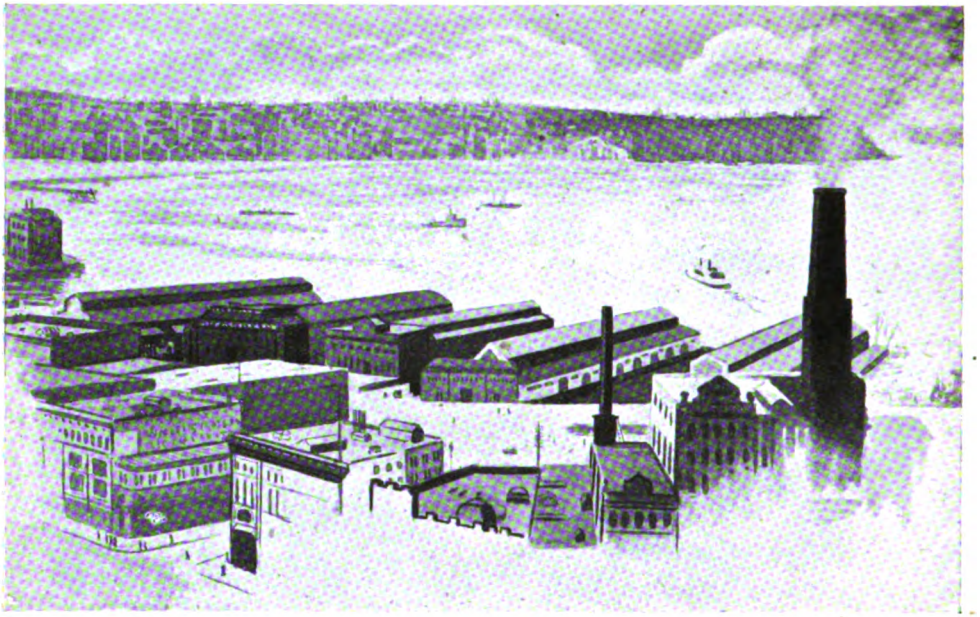

A VIEW OF THE HARBOUR, SEATTLE, WASHINGTON, U.S.A.

Looking up from the contemplation of these little strangers my eyes followed the outstretched arm of my tormentor and, guided by the pointing finger, finally rested upon the legend " Pay Here " in large gold letters. Then the truth dawned upon me : I was in debt to the extent of one dollar fifty cents ! Six shillings and threepence for a haircut ! My word !

I met my colleague at the cash desk and, without enthusiasm, we paid up. On our way back to the boat we discussed plans for the formation of a society for the protection of hapless travellers.

First impressions, although notoriously misleading, are hard to eradicate, but eventually I became quite attached to Seattle. At the time of my visit the city had been very badly bitten by the wireless bug and aerial masts grew profusely in suburbia. Many hotels proudly flaunted aerials which, more often than not, bore evidences of originality on the part of the designer. Even the offices of shipping agents boasted of their wireless stations. Amateurs rended the æther from morn till night with hideous dots and dashes without let or hindrance, for in those days there was no official control over their activities. One expert of eighteen, normally a lift attendant, had a two-kilowatt set which he proudly told me he had made himself, " all bar the receiving 'phones." Another enthusiast had a fearful and wonderful installation which scaled no less than seven kilowatts and blinked all the lights in the neighbourhood.

Considering that I had been doing 200-300 miles with a $\frac{1}{3}$-kilowatt set it is no wonder that I marvelled at this prodigality, but they assured me that electric power was so cheap that it did not pay to instal meters on consumers' premises. A few

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dollars a month secured an unlimited supply of electricity much in the same way as we get our water supply.

Seattle University had a fairly powerful station with a low-spark frequency, and on more than one occasion I had to tell the operator to "put the soft pedal on his thunder factory," after which he refused to work with me. This, of course, was of little consequence, as the place was bristling with wireless stations which recognised no laws, rules, or claims of priority, but it led to rather an interesting little incident.

A few hours after leaving Seattle an urgent message was handed in addressed to a resident in that city, and I couldn't get P.A. to take it. My call was picked up at one of these private stations by a gentleman who considered himself under an obligation to me for some reason or other, and he offered to put it through. I thanked him, sent the message, and asked him to rush it, as a reply was expected while we were still within range. He then made the brilliant suggestion that time might be saved by telephoning it through if the addressee happened to be on the 'phone and confirming the message later in the usual way. As luck would have it the sender knew the telephone number, and soon my ally knew it also. He said, "Hold on and I'll give you your reply right away." I thought he was a very confident young man, even for an American, but sure enough the reply came along in a very few minutes, much to the astonishment of the sender. So pleased were we all with the success of the manœuvre that we prolonged the conversation until cut off by the telephone exchange operator, who did not fully appreciate the honour of being a link in this wonderful chain. I need hardly say that the log-book

"THE NIGHT HAS A THOUSAND EYES, AND THE DAY BUT ONE."

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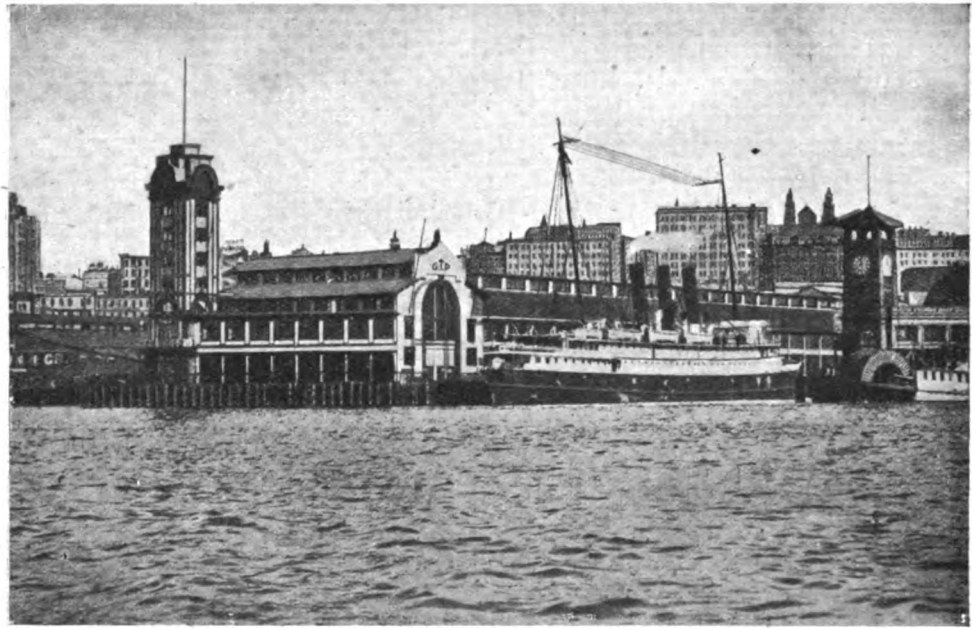

THE BUSY WATER-SIDE, FRINGED WITH WHARVES AND BACKED BY GIANT BUILDINGS.

entry on this occasion was not exactly "gospel," but then, of course, one must occasionally make sacrifices in the interests of science, *n'est-ce pas?*

It is scarcely necessary to point out that this sort of thing is not permissible nowadays. Even before the war the U.S. Government had taken the ubiquitous amateur to task and limited the scope of his activities, but in the days to which these reminiscences refer wireless had become a cult with them.

Several of the more enterprising followers of this wireless cult actually went so far as to endow themselves with high-sounding titles and solicit wireless business, trotting out gaudily printed telegraph blanks to prove their bona-fides. When the Marconi Wireless Telegraph Company of America was reorganised in April, 1912, they dropped out of business.

I shall never forget the agent's clerk in Seattle who tried to get medical advice on the cheap. The purser had pointed him out to the doctor as " . . . the meanest man in the United States. He'd squeeze a cent until it cried for help. Always thinks he's got something the matter with him, he does, and makes a bee-line for the ship's doctor, so as to get physic for nix."

Sure enough he came along later on in the day with his tale of woe, and the doctor, with his best professional manner, took him into his cabin and shut the door. The purser turned to me and said: "Who'd have thought that the doc would have fallen for it so easily after I'd warned him? That stiff is as right as I am." "You leave it to the doc," I replied; "perhaps he's going to teach him a lesson." "Maybe you're right, Sparks. I thought I detected a grin on the doc's face when I was telling him. Let's hang around and see if there's any fun," he suggested.

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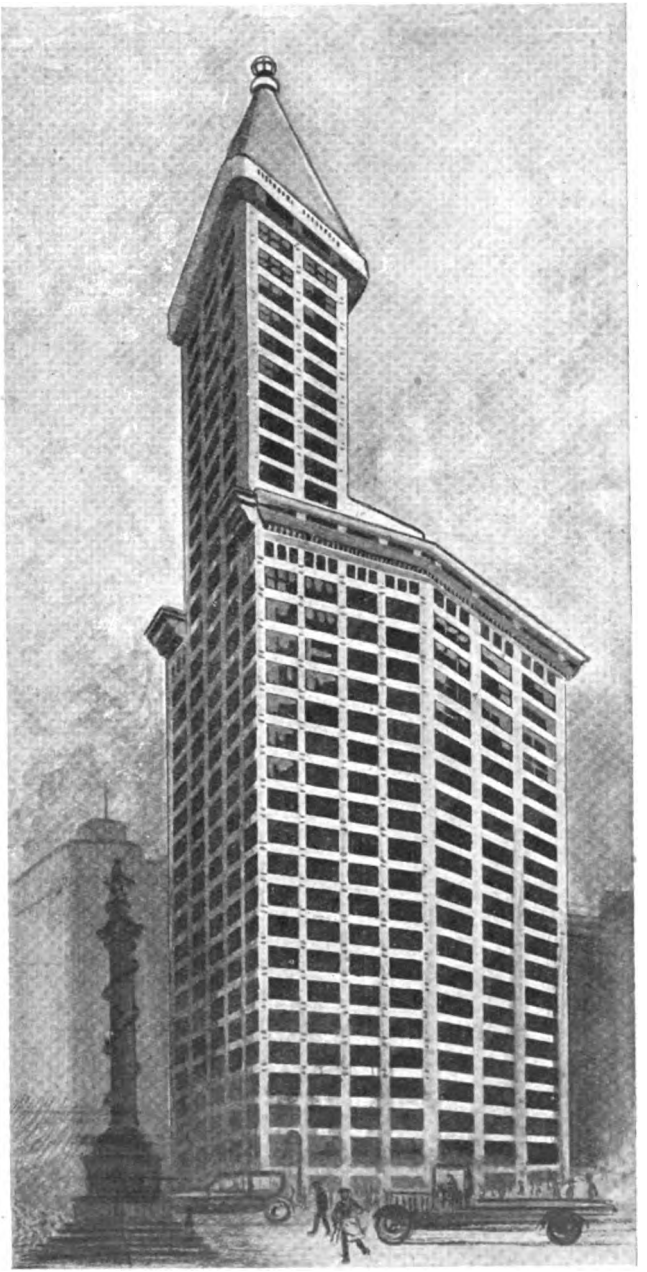
There was no excitement, however. The fellow came out a few minutes later looking very sorry for himself. My companion hailed him. "What's wrong this time, Charlie? Is it your pump or your bellows?" "You go to Elgin!" he retorted, with which cryptic remark he disappeared down the gangway.

We sought out the doctor, who told us that he complained of sore eyes and pains in the head. "So I examined him carefully," said that worthy, "and told him that his was a most remarkable case, as the brain was enlarging, and, being confined by the skull, was pressing against the back of the eyes, causing the pain and soreness of which he complained. I pulled out my instrument case, and said casually that I'd remove a small portion of the brain to ease up the pressure and save the eyes from being pushed out. But he wasn't having any! Said he'd like a day or two to think it over."



W. C. SMITH BUILDING, SEATTLE: THE HIGHEST IN THE WORLD OUTSIDE NEW YORK CITY.

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A Distinguished Public Servant.

Elliot & Fry.

THE LATE Mr. E. W. FARNALL, C.B.

For many years Assistant Secretary to the Post Office, and British Plenipotentiary to the International Radiotelegraphic Convention of 5th July, 1912.

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A Notable Personality

THE public service in general, and the radiotelegraphic world in particular, have sustained a severe loss through the death of Edmund Waterton Farnall, C.B., who passed away at the age of sixty-three on April 14th last. It is forty-one years ago since he entered the service of the Post Office, at a time when the halfpenny postcard was but recently introduced, and only a very few years subsequent to the absorption of the wired telegraphic system by the G.P.O.

During the course of Mr. Farnall's career he was connected with many phases of Post Office activity, and attained the distinguished position of Assistant Secretary in 1906, continuing to discharge the duties of that post until his retirement at the end of 1917. In this capacity he was vested with the control of foreign and colonial posts and telegrams, including the administration of wireless telegraphy both in its national and international aspects.

His exceptional ability and energy found full scope in the discussion of many important matters affecting the International Postal and Telegraph Services ; whilst his amiable qualities won for him the esteem of the representatives of other administrations with whom he came into contact from time to time. The officials of the steamship and railway companies concerned in the conveyance of foreign and colonial mails, as well as those of the cable and wireless companies, found in him an administrator always ready to treat sympathetically any proposals put forward with the object of securing improvements in the various services affected. Personality possesses a powerful influence in Affairs, and the good relations thus established proved fruitful in procuring concessions favourable to public interests.

Mr. Farnall's attention was first directed to wireless telegraphy when its importance from an international point of view had been firmly established, and he became one of the leading public officials dealing with the subject. His duties brought him into close contact with Senatore Marconi, as well as with other prominent men concerned in the development of the science ; and, although his functions as an administrator necessitated at times a course of action which conflicted with their views, his personality and honesty of purpose gained for him their highest esteem. His eminent official position with regard to wireless is attested by his selection to act as one of the British delegates plenipotentiary at the International Radiotelegraphic Conference held in London on July 8th, 1912.

In Post Office circles Mr. Farnall gained the close friendship of all his colleagues, whilst the large staff under his control in the foreign and colonial branch of the Secretary's Office highly appreciated his kindness of disposition and easy accessibility.

He made his home at Blackheath, where his family had been established for many years, and in his private life took a large interest in charitable and other institutions. Born in 1855, he married in 1894 a daughter of Mr. Leonard Bidwell, who was for many years Chief Clerk to the Post Office. Like his brother, Mr. H. B. Farnall, C.B., C.M.G., lately a British Commissioner of the *Caisse de la Dette Publique* of Egypt, he was a brilliant linguist and a man of great personal charm.

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The Evolution of the Thermionic Valve (III.)

By R. L. SMITH-ROSE, B.Sc., A.R.C.S., D.I.C., Student I.E.E.

Read before the Students' Section of the Institution of Electrical Engineers on January 22nd, 1918.

NOTE.—The first part of this valuable paper appeared in our April issue, pp. 10 *et seq.*

THE "AUDION" DETECTOR AND AMPLIFIER (*continued*).

THE intensity of the sound depends upon the voltages of the batteries B_1 and B_2, and the best position can be found by adjusting these while listening to the note received. When the best adjustment has been obtained, it will be found that the intensity of the received signals is several times as great as those which would have been obtained by connecting the receiver directly in the receiving circuit, showing that this "audion" valve has acted in a true sense as an amplifier of the received signals, exerting a kind of relay action, quite distinct from the simple rectifying properties of the Fleming valve. The audion, however, differs from the most perfect contact relay device in giving a quantitative response—that is to say, up to the saturation currents for the gas space within the bulb, the change in plate current is approximately proportional to the grid voltage.

Lee de Forest made numerous experiments with tungsten and other filaments, with platinum coated with alkaline metals or salts, and with various gases and vapours in the bulb, but he did not succeed in increasing the sensitiveness obtained with a Tantalum filament, and with atmospheric air exhausted to the highest vacuum. He found the best value of the battery B_2 potential, required to produce the maximum sensitiveness, depended upon the degree of evacuation, being roughly proportional to the same.

When the voltage of this battery B_2 is sufficiently raised, the ionic discharge from the hot filament cathode becomes visible in the form of a blue glow, occupying practically the whole bulb. A similar blue glow may be brought about in normal working if a powerful spark discharge occurs in the neighbourhood of the audion, causing a momentary large potential to be impressed upon the grid. The appearance of this blue arc is always a sign that the bulb is being over-run, as regards the current passing from plate to filament. In this connection an interesting phenomenon may be observed in certain bulbs when the voltage of the battery B_2 in the plate circuit is adjusted until the blue glow is just visible round the edges of the plate. Then, when powerful impulses are received on the grid, a momentary flaring out

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of this blue aura can be observed with each signal so that it is possible to read the telegraphic signals by sight.

The possibility of this blue glow effect, together with other properties which arise from the presence of some remaining gas in the bulb, gives rise to certain irregularities in the working of the "audion" which set it at some disadvantage to a modified form, much more highly exhausted, to be described later in the paper. The presence of the blue glow is also very detrimental to the life of the valve, owing to the disintegration of the filament caused by the intense bombardment by the positive ions.

A great advantage which the thermionic valve amplifier has over any other relay device is that there is no lower limit of sensitiveness; for, if the original impulse received is too minute to be directly discernible, it may be amplified one or more times, and the effect of the original impulse will be observed to exist. The simplest arrangement of connecting two amplifiers in cascade to obtain increased magnification is shown in Fig. 10.

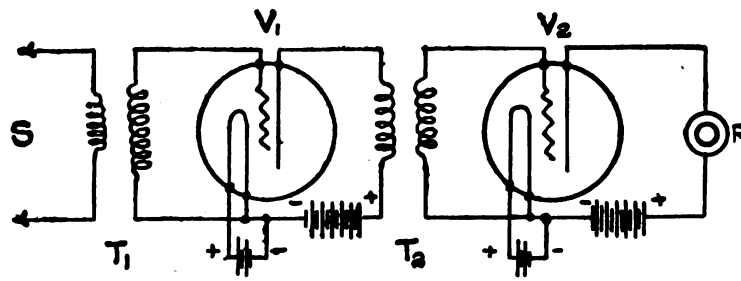

FIG. 10.

A step-up transformer, T_1, is provided if the original impulses coming from S are of low voltage, the secondary winding being connected across from the grid to the filament of the first valve as shown. In the plate circuit of this valve is included the primary of the transformer T_2, the secondary winding of which transfers the amplified impulses from the first valve to the grid circuit of the second. Similarly valve No. 2 may actuate a third, and so on, the successive steps requiring as a general rule larger bulbs with larger heating areas and electrode surface to carry the increasing currents. In this manner the received signals, after having been rectified to the form of impulses of audible frequency, may be further amplified several times, the alternating potential applied to the grid of each valve producing synchronous, amplified variations in the corresponding plate current in accordance with the sloping part of the characteristic curve in Fig. 9. The receiver placed in the plate circuit of the last valve will then be operated with the total amplified current obtained from the original impulse.

De Forest, making measurements of the amplification by the shunted receiver method, found that a good bulb gives an amplification of five times, and with three in cascade he obtained a magnification of 120 times, this including the losses in the three transformers in circuit.

The audion has a further advantage as a magnifier in the absence of any periodic or very delicate adjustment, and also in its freedom from the effects of mechanical vibration or disturbances.

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The immediate use of this valve for amplifying and rendering readable signals which were previously inaudible will be obvious, giving, as it does, a greatly increased receiving range for any wireless station.

(4) THE LIEBEN-REISZ VALVE.

At the same time that De Forest was investigating the three-electrode valve Messrs. Lieben and Reisz were carrying out experiments in Vienna on a gas valve

FIG. 11. THE LIEBEN-REISZ VALVE.

containing a somewhat different form of ioniser, utilising the fact discovered by Wehnelt in 1904, that strongly heated oxides of certain metals, particularly those of calcium and barium, emit electrons at very low voltages.*

*Wehnelt, *Phil. Mag.*, x., p. 80 (1905).

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Willows and Hill described some experiments in 1911, making use of this fact to obtain increased ionic emission and sensitiveness in a modified form of Fleming valve.* They used electrodes of platinum, both of which could be heated by a current. The cathode was coated with calcium oxide (lime), which emits negative electrons on being raised to a white heat, while the anode was covered with aluminium phosphate, which gives out positive ions when raised to a dull red heat. They found that this method gave improved rectification and greater sensitiveness than the ordinary Fleming valve.

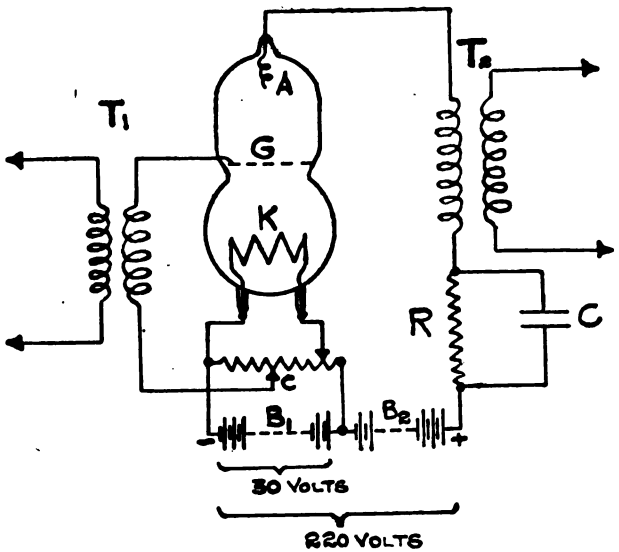

FIG. 12

The final form of the Lieben-Reisz valve was described by one of the inventors in 1914.† A general view of the tube and the arrangement of the connections are shown in the accompanying Figs. 11 and 12.

The Wehnelt cathode, *K*, consists of a platinum strip 1 metre in length, 1 mm. wide and 0·02 mm. thick, wound in a zigzag form upon a glass support, the strip being coated with a thin layer of calcium oxide or barium oxide. The grid, *G*, is a circular aluminium plate perforated with holes about 3·5 mm. diameter, while the anode, *A*, is a short spiral of 2 mm. aluminium wire.

The three electrodes are mounted in an evacuated glass vessel of the shape illustrated, the approximate dimensions of the valve being 16 inches long by 4 inches maximum diameter.

The cathode is brought to a bright red heat at a temperature about 1,000° C. by a battery, B_1, of about 30 volts. A certain steady voltage is impressed upon the grid from the sliding contact, *C*, on the potentiometer connected across the heating battery. The current to be magnified is led to the grid through the transformer T_1, the amplified current being drawn from the secondary of the transformer T_2. The necessary working voltage in the anode circuit is about 220, and a resistance, *R*, is included to prevent too great an increase in the discharge current, a condenser shunt being provided for the amplified alternating current.

In the early experiments it was found difficult to obtain a uniform discharge owing to the variation of the gas pressure inside the tube, this giving varying sensitiveness and entailing constant adjustment of the grid and heating voltages. It was therefore decided to replace the gas discharge by a vapour discharge by

* Willows and Hill, *Electrician*, lxviii., p. 302 (1911). † Reisz, *Electrician*, lxxii., p. 726 (1914).

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introducing mercury vapour into the tube, constancy of pressure being obtained by keeping a small quantity of liquid mercury in a small side tube attached at the bottom of the main tube.

Actually in the final form of the valve an amalgam of mercury with a lower vapour pressure is used, as the vapour pressure of mercury rises rapidly at temperatures about 20° C., this giving rise to high current densities at the cathode sufficient to cause fusion of the platinum strip.

Although the discharge is maintained by the glowing oxide cathode, the majority of the current is carried by the mercury vapour, and thus the "ageing" of the tube, due to the occlusion of the residual gas, is very small, and a life of from 1,000 to 3,600 hours is obtained.

The inventors claim an amplification of 33 times for this type of valve, independent of the amplitude of the primary current, and that using four such valves connected in cascade, alternating currents of frequencies ranging from 2,000 to 8,000 cycles per second have been magnified 20,000 times with perfect reproduction of the original wave form.

This form of gas relay has been adopted by the A.E.G. and is used by the Telefunken Company as an amplifier for received radio-telegraphic signals; but it is probable that the large size of the tube and the high voltages required to operate the valve will seriously limit its field of application in spite of the high value of the magnification obtained.

(5) THE PURE ELECTRON DISCHARGE VALVE.

In the types of valves already described, employing the thermionic currents obtained in an evacuated bulb, the latter always contained a certain amount of residual gas. In this respect we must state that a pressure of the order of 1–10,000th mm. of mercury indicates that a relatively large amount of residual gas is present in the bulb.

This residual gas, as we have seen, had a very considerable influence on the operation of the valve in supplying positive ions within the bulb, which neutralised to a great extent the space-charge effect of the electron currents between cathode and anode, and enabled comparatively large thermionic currents to be passed under potentials of 50 volts or less. But the presence of gas to this extent within the bulb has been found to carry with it certain disadvantages. In the first place, the characteristics of the valve tend to become very irregular, the current-voltage curve often showing decided kinks at moderately high voltages. In many cases also, when working at high cathode temperatures and at high anode potentials, the discharge becomes very unstable at certain points, and the characteristic for increasing voltages is somewhat different from that in the reverse direction. All these effects, moreover, vary with the composition and pressure of the contained gas, and both these vary with the intensity and duration of the discharge passing through them, the pressure decreasing considerably after a time similarly to the manner in which an X-ray tube becomes "hard" after prolonged use. Another effect of the positive ionisation within the valve is the tendency to disintegrate

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the cathode by the bombardment of the positive ions, and so considerably diminish the life of the valve.

Most, if not all, of these defects are absent in the pure electron discharge type of valve, which is the outcome of the investigations of Dr. Langmuir in the General Electric Company's research laboratory at Schenectady, N.Y. In this valve the evacuation of the bulb is carried out to the highest possible degree to eliminate all positive ionisation ; in which case, as shown by Langmuir, the electron emission from the cathode follows Richardson's equation absolutely, and the corresponding thermionic currents can be obtained, providing sufficient voltage be applied to the anode to overcome the space-charge effect of the electron stream from the cathode.

To distinguish this type of valve from those containing some residual gas, the term "Kenotron" has been applied to it, derived from the Greek "Kenos," signifying "a vacuum," and "Tron," "an instrument." This name has since become generally applicable only to the form of the valve containing two electrodes, and used as a rectifier, the term "Pliotron," signifying "an amplifier," having been designated to a kenotron provided with a third electrode or grid to convert it into an amplifier of alternating currents.

As an example of the first use of a kenotron, mention may be made of the X-ray tube invented by Dr. W. D. Coolidge in 1913.* In this tube the cathode is formed of a small flat spiral of tungsten wire surrounded by a cylindrical sleeve of molybdenum which serves as a focussing device, while the anode, or target, consists of a massive piece of wrought tungsten supported near the centre of the tube by a molybdenum rod. The tube is exhausted to the highest degree in the manner described below, and the vacuum is such that, unless the filament is heated, the tube shows no conductivity in either direction even with a voltage as high as 100,000. With the filament heated the tube can be used for the production of X-rays with voltages as high as 200,000, and the intensity of the discharge can be completely controlled by varying the temperature of the cathode. The current through the tube is absolutely unidirectional owing to the absence of gas, and there is no heating of the cathode by the discharge current, and no evidence of any disintegration of the cathode. These factors enable the tube to be run continuously at a high energy input, while the intensity of the discharge remains quite constant.

(*To be continued.*)

Long Distance Communication

AN item which (if correct) illustrates the long distances covered under modern conditions, as a matter of course, by high-power installations, has recently been recorded in the pages of one of our contemporarie . The *Telegraph and Telephone Age* reports that Java and Holland are now in communication by wireless over a distance of 10,000 miles. The station at Bandoeng, Java, is—according to our contemporary—transmitting 5,000 words daily to Scheveningen, a seaside resort of the Hague. It is 2,800 ft. above sea level. The Java station was built by Mr. Van der Groot, a Dutch wireless expert of established reputation.

* W. D. Coolidge, *Electrician*, lxxiv., p. 505 (1915) ; British Patent 14,892, 1913.

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Digest of Wireless Literature

The Dynatron and Pliodynatron.

The dynatron belongs to the kenotron family of high-vacuum, hot-cathode devices. It resembles the kenotron and pliotron in construction, but the action is fundamentally different. The kenotron rectifier utilises the unidirectional property of the current between a hot and cold electrode in vacuum. The pliotron utilises the space charge property of this current, which allows the current to be controlled by the electrostatic effect of a grid. The dynatron utilises the secondary emission of electrons by a plate upon which the primary electrons fall. It is, as its name indicates, a generator of electric power, and feeds energy into any circuit to which it is connected.

The dynatron is a vacuum tube containing a hot filament, a perforated anode, and a third electrode called the plate. The anode is placed near the plate and between it and the filament, and holes in the anode permit electrons from the filament to reach the plate. The anode may be in the form of a perforated cylinder, a spiral of wire or cylindrical network of fine tungsten wire. When the voltage of the plate with regard to the filament is sufficiently raised the electrons strike the plate with a velocity high enough to cause the emission of secondary electrons from the plate. These secondary electrons are attracted to the anode, which is kept at a more positive potential by a battery connected between the filament and the anode, and the net current received by the plate is the difference between the number of electrons that enter and leave it. As a result the characteristic relation between the current and the voltage is denoted by a curve for the current that rises from zero to a maximum at about 50 volts, thence decreases through zero at 100 volts to a negative maximum at about 150 volts, and then becomes positive again. It will be noted that in the region between 50 and 150 volts the current decreases with increase of voltage and the tube has the property of possessing a "negative resistance."

This feature of the tube renders it suitable for many important uses. If connected in series with a circuit containing a positive resistance the total resistance may be made as small as desired, and small change in the voltage applied to the whole circuit will cause a comparatively large change in the current flowing—*i.e.*, the circuit acts as a voltage amplifier. If connected in parallel with a circuit containing positive resistance the total conductivity of the circuit can be made as small as desired, and the circuit then acts as a current amplifier. If connected in a circuit containing resistance, inductance and capacity, the damping may be made

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very small, so that impressed oscillations may persist for a very long time, or the damping factor may be adjusted so as to be negative, in which case continuous oscillations will be set up. Oscillations of this type will arise if $Rr = L/C$, where R and r are the resistances of the circuit and dynatron respectively and L and C the inductance and capacity of the circuit. Tests are described that confirm these results, and it is found that a dynatron short-circuited by a couple of turns of heavy wire will generate at a frequency as high as 20,000,000 cycles a second or as low as 1 cycle a second. The wave-shape follows a sine law when $Rr = L/C$ and is distorted when this relation is not fulfilled.

The characteristics of the tube are greatly modified if a magnetic field is caused to act parallel to the axis of the anode. The spirally moving electrons are then stopped to a greater extent by the anode and less electrons reach the plate. Furthermore, the fields restrain the secondary electrons from leaving the plate. As a result the tube passes from having a negative resistance to having a positive one.

If an electrostatic field is impressed by means of additional plates inserted into the tube, the negative resistance of the tube may be controlled by the strength of the electrostatic field. The tube thus controlled is called a pliodynatron, which may be used as a powerful amplifier, as a radio generator, or, together with a transmitter, as a radiophone for wireless telephony, or as a sensitive detector in a telephone receiver circuit. A number of these applications are described in detail. (A. W. Hull, Institute of Radio Engineers, *Proceedings*, February, 1918.)

SUBDIVISION OF CONDUCTORS CARRYING ALTERNATING CURRENTS.

An account of experiments carried out at the Physikalisch-Technische Reichsanstalt on the subdivision of conductors carrying alternating currents of great amplitude or high frequency, in order to reduce the eddy current losses resulting from uneven distribution of the current in the conductors. It has recently been shown that coils made of compound flexible conductors do not always have lower resistances than coils made of solid conductors of the same total section. In fact, above a certain frequency the subdivided conductor may have even higher copper losses than the solid one. The author investigates the effect of subdividing twisted bar conductors lying in slots, and of winding compound flexible cables into coils.

It is found that if the height of the bars is small their resistance is diminished by any subdivision, but if the height of the bars is great the reaction of the eddy currents is considerable, and the conductor must be subdivided beyond a certain limit if its resistance is to be thereby decreased. If a smaller subdivision than is fixed by this limit is made, the effective resistance is increased instead of decreased. There is a certain most unfavourable subdivision that increases the resistance to a maximum value. It will thus be seen that the resistance of flexibles increases as the conductor is subdivided more and more until a critical value of the subdivision is reached, after which further subdivision will decrease the resistance until it ultimately reaches the steady current value. Formulæ are given to determine the resistance of subdivided conductors from their dimensions, and their use enables stranded conductors to be so chosen as to be best suited to fulfil the conditions of any particular case. (W. Rogowski, *Archiv für Elektrotechnik*. No. 4, 1916.)

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USEFUL RADIO INSTRUMENTS.

IN many circumstances, particularly during war time, it is inadvisable to test a wireless transmitter with the aerial connected in circuit. A recent issue of our American contemporary, the *Electrical Experimenter*, describes a form of "phantom" antenna, designed, as a matter of fact, for testing aeroplane wireless sets, although the principle can be applied to the testing of radio installations of any type.

The instrument in question consists of what may be called concentrated capacity and inductance of the correct oscillating proportions, and so designed as to permit of passing through or into it the same amount of energy in watts as would be sent into the actual aerial under working conditions. The idea is somewhat similar to the connection of a water resistance to a dynamo under load test. The particular phantom antenna described comprises a mica condenser of ·004 M.F. capacity connected in series with a resistance of 4 ohms, which approximately duplicates the average *trailing wire* aeroplane aerial and has a carrying capacity of 1·5 amperes, as indicated by a hot-wire ammeter. It will stand normally a breakdown potential of 7,000 to 8,000 volts, and is said to be very useful for tuning and testing aeroplane or other radio transmitters on the ground.

Another new device described in the same article comprises a small inductance and large capacity in series with a crystal detector, with terminals provided for connecting a set of head telephones. It is useful as a tone tester for observing the quality of tone of a transmitter, but its greatest utility is said to be in its use in determining the point of resonance in oscillating circuits which are being excited by damped waves.

In measuring the natural period of an aerial the device may be coupled loosely to the grounded antenna, a buzzer-excited wavemeter being also coupled to the antenna at a point slightly removed from the instrument. When the wavemeter is then varied a loud response will be heard in the telephones when the wavemeter is in resonance with the natural period of the aerial. The article states that this is by far the quickest way to obtain the natural period of an aerial, although ourselves we cannot see that the method is any quicker or simpler than that used in this country with the Marconi Portable Wavemeter.

Philadelphia Honours Senatore Marconi

THE world-famous Franklin Institute of Philadelphia, one of the leading scientific foundations in the great Republic, which owes its initiation to the celebrated philosopher and statesman, recently awarded their medal, *honoris causa*, to Senatore Marconi. The formal presentation was made, in the absence of the "Father of Wireless," to Count di Cellere, the Italian Ambassador. The latter returned thanks in an eloquent speech, in the course of which he said: "This medal will always "remind Guglielmo Marconi of the admiration you men of science and all of us have "for him. In accepting, in his name, this token of your esteem, I thank you, "gentlemen. May the friendship uniting this great Republic and Italy be as lasting "as the medal on which the name of the inventor is indelibly engraved."

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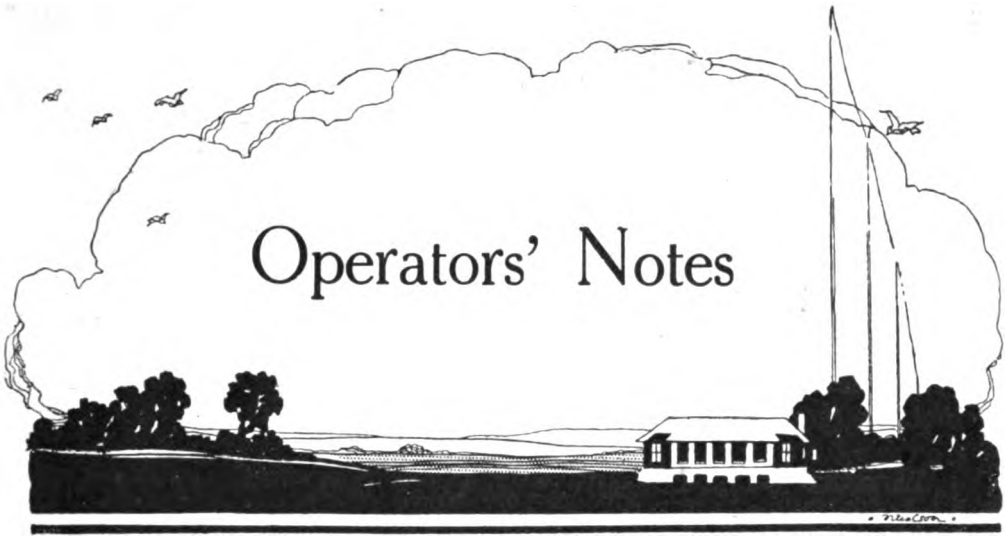

Tools and How to Use Them (II.)

By HAROLD WARD

Screwdrivers.

Always use the screwdriver which most nearly fits in the slot in the head of the screw. A loose-fitting screwdriver burrs the edges of the slot and causes much difficulty when a screw has to be removed. Don't use screws out of proportion to the size of a job. Too large a screw is as big a mistake as one too small. When screwing into soft wood only a small starting hole is needed, though a much larger starting hole will be necessary in hard wood, such as the mahogany top of the operating table. When inserting a screw a little vaseline smeared on its thread will lighten the labour both of insertion and possible removal at some future date. If a screw jams in hard wood, it is useless to force it in further or you will find either half the head break off, or else it will break half way down the shank. A jammed screw should be removed, the hole enlarged and more grease applied before attempting to drive it home. A screw which refuses to turn for removal may sometimes be loosened by a sharp tap with hammer, or by a tightening twist before again trying to unscrew it.

Soldering Bolt.

When dealing with insulated or aerial wire, always use the bolt in preference to the blow lamp, as apart from the injury which excessive heat causes to the wire, it also tends to destroy the insulation. Cleanliness is the prime necessity of successful soldering. It is a good plan to keep a tin lid with a little solder and flux in it for use with the bolt. If the bolt be heated, cleaned, tinned, and dipped into this lid, sufficient solder will adhere to it to make a small joint, such as is required at ends of the primary and secondary of the magnetic detector.

Spanners.

Using a spanner which is too large results in a rounded nut which is both unsightly and troublesome. Should you not have a spanner small enough, try inserting the end of a screwdriver between one of the jaws and the nut. If a nut

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sticks it may sometimes be loosened by giving spanner a sharp jerk in the direction for tightening and then exerting a steady strain in the right direction. A steel nut which has rusted can frequently be loosened by judicious tapping with a hammer. Care must be taken, however, not to burr up the thread of the bolt. Paraffin oil is useful for freeing rusty nuts. Should a nut defy all efforts with a spanner and there is not time to coax it with oil, hold the cold chisel at one corner and knock it with the hammer in the direction for unscrewing. Sometimes it is necessary to cut off a nut, in which case it is advisable to saw down through it at one corner as close to the bolt as possible. This will generally permit of its being removed with a spanner which is always safer than cutting right through the nut with your cold chisel. Spanners should not be used as hammers or levers for opening cases.

TOMMIES.

When these are used, the screw should be coaxed, as a sudden strain will snap their hardened points.

VICE.

This tool should be firmly screwed down in some convenient position so as to be ready for immediate use. The top of tool box is handy. It should, of course, be removed and locked up when leaving the ship. Don't screw the vice on to operating table. If using the vice as an anvil, do not hit too hard, because, being made of cast steel it breaks very readily. "Clamps," which are protective linings for the steel jaws and are used to prevent smooth surfaces being scratched by the roughened grips, are generally made from strip lead, but in emergency strips of wood can be satisfactorily used for this purpose. Never grip any article in a vice tighter than is necessary to secure rigidity. File scratches and saw cuts on top of vice jaws are signs of an untidy and careless worker. Ebonite, such as a Bradfield tube, should be well wrapped round with a rag before being gripped in a vice, or it will chip.

GENERAL REMARKS.

The custody of the tool box is an important matter, all tools being replaced in it immediately after use, for safe keeping. The lid must not be used as a substitute for a bench to work on. This is not its function, and, moreover, the wood is likely to split and break, if, for instance, hammering is done on it.

There are usually sufficient tools on board a ship to meet all ordinary requirements, though occasionally an unusual breakdown occurs which demands special appliances. These can generally be borrowed from the chief engineer.

Look after your tools carefully and they will prove to be of great use to you. Don't lend them indiscriminately. On the other hand, do not curtly refuse the loan of any of them. You may, as shown above, have occasion to borrow tools, and if you do lend a tool, remember you are responsible for it, and see that you get it back in good condition.

Any small tools which may have been kept handy in drawers, etc., for the sake of convenience during the voyage, should be returned to their proper places on arrival in port. A bad workman may blame his tools, but a good workman is severely handicapped without the tools requisite, which ought to be, but are not, available for work to be done; therefore be particularly careful to keep the tool box locked, especially when leaving the ship.

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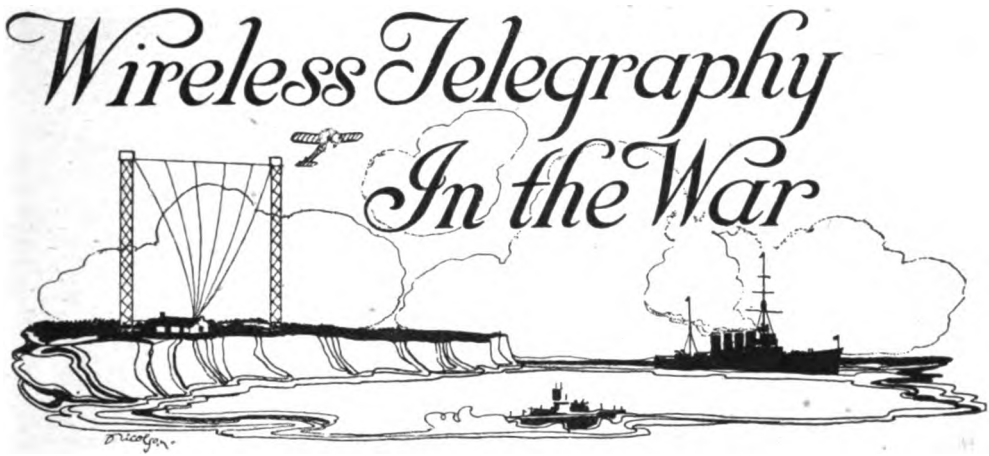

THE WIRELESS OF A BLACK REPUBLIC.

IN our issue of July, 1917, page 261, we referred to the "Purging of Africa" from German wireless influence, at that time furthered by the declaration of war against Germany on the part of Liberia. In the course of April last we received news of the shelling of the wireless station at Monrovia, the principal port of that Black Republic, by a German submarine. Seeing that, by the "north-about" route, the distance between Heligoland and Monrovia has been estimated at about 5,000 miles, we have here apparently to deal with a long-distance voyage on the part of a submarine, which reveals in a startling way the cruising powers of the later types of under-water craft.

This Negro Republic formed part of the "back to Africa" movement which was so active during the first part of the nineteenth century. Our illustrations on pages 154 and 155 show the French and German stations erected there. Both of them had a daylight range of about 300 miles and night range of about 600 miles, and both installations were dismantled at the outbreak of war. The former had, however, resumed operations; and the enemy therefore took the earliest opportunity to "strafe" it with his guns.

We have little information as to the effect of the Hun bombardment; whether his object was attained or whether merely wanton damage was done to the Liberian inhabitants. We notice, however, it has been maintained that the U-boat commander was not justified in directing an act of war against a totally unfortified town. In view of the fact that radiotelegraphic activities are in wartime frequently of considerably more importance than fortifications, we find ourselves inclined to take the view that this German attempt to destroy an enemy installation was no illegitimate task. There are so many undeniable instances of outrages against every sense of decency and moral obligation to be set down against the Germans and their Government, that it would seem a thousand pities to strain a point on so doubtful a matter as the one in question. Any "learned counsel" will tell you that it is perfectly possible to spoil the best of cases by over-statement.

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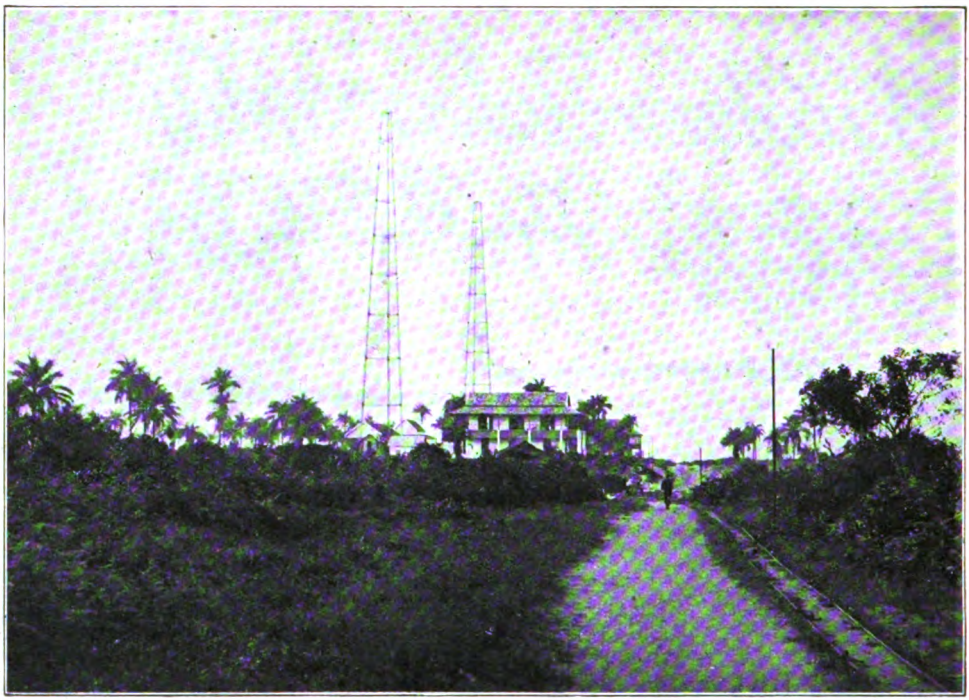

FRENCH WIRELESS STATION IN MONROVIA

SCIENTIFIC WARFARE.

How often we see in British reports of fighting, especially on the Western front, such phrases as "the enemy operations were favoured by a heavy fog"; or "our "men struggled heroically against adverse weather conditions"! Now, according to the Teutonic way of looking at things, such references are easily explained. The Huns and their hellish deeds receive the smile of approval from the deity whom they worship, and his aid is always available for a Hohenzollern, ruling by Right Divine as his vice-regent and ally!

But I suppose that we British may be pardoned for unwillingness to accept such an explanation. The careful collation of meteorological observations, reports and statistics has, over a considerable period in the past, enabled scientific men to foretell, with a fair amount of accuracy, the weather which is likely to affect definite areas at certain specified times. The introduction of wireless into world-wide use profoundly modified and extended this fore-knowledge; and, in the *Wireless Year Book*, one of the annual features consists of an article enumerating the *International Time and Weather Signals* established by the various nations of the world in order (*inter alia*) to facilitate the compilation of such prognostications. Before the commencement of hostilities, weather forecasts, based largely on wireless reports from vessels crossing the Atlantic, used to be regularly issued by the British Meteorological Office. For the express purpose of withdrawing such facilities from enemy use, one of the earliest steps taken in this country was to suspend the issue of the forecasts. But it is not sufficient for any Government to prevent the

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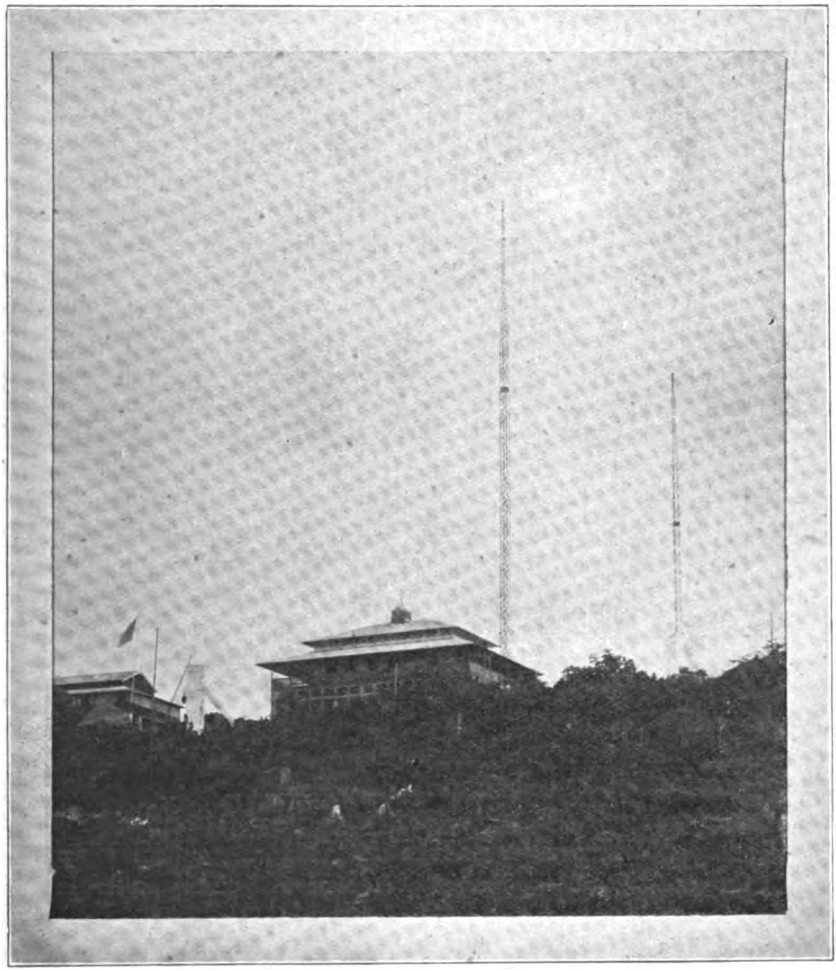
GERMAN WIRELESS STATION IN MONROVIA.



OUR VIEW SHOWS AN INSTALLATION ERECTED DURING PRE-WAR DAYS, BY OUR PRESENT FOES, IN THE CAPITAL CITY OF THE LIBERIAN REPUBLIC.

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utilisation of information by the enemy, it is even more important to see that such means are taken full advantage of by their own leaders. The Allies, with their world-wide facilities, with their vast fleets constantly traversing the oceans, and with the multitude of wireless stations at their disposal, should be in a far better position than their adversaries for availing themselves of favourable phases of weather conditions, and timing their operations accordingly.

It is an open secret that the German Headquarters Staff proceed in a serious and businesslike way with regard to weather reports and the forecasts based upon them. We have seen evidence of this procedure, not merely on the battle front, but also in the case of Gotha and Zeppelin raids. It would be a matter well worthy the attention of some influential and patriotic Englishman to ascertain confidentially from the proper sources whether our own Weather Bureau works as scientifically as the enemy's, and whether the information they provide receives anything like the same attention on the part of *our* military leaders as does that furnished by the methodical Germans from Hindenburg, Ludendorff and company.

MORE SPY WIRELESS.

The treason trial of some German spies at Genoa, towards the end of March last, resulted in the condemnation to death by shooting of Kœnigsheim, Ampt, Martell and Haas *in contumaciam*, four subordinates receiving sentences of from ten to twenty years' hard labour. Interesting particulars came out in Court concerning the way in which our enemy, during the early stages of the war, forwarded wireless material to America for utilisation in spy and propaganda work. Radio-telegraphic apparatus was transmitted from Berlin to the care of the Genoese Electrical Power Company, and conveyed from Genoa to its final destinations. As a reward for his treasonable activities Ampt received a decoration of merit from the Imperial German Government.

The four condemned men mentioned above were genuine Germans, and the principal directors of the Genoa Electrical Company. They managed to escape from Italy before the latter country joined in the struggle, and it was only because they were for the moment beyond reach of the Italian Courts that they were condemned *in contumaciam*. The principal point of interest for ourselves lies in the transmission of wireless apparatus to German agents abroad, who were evidently considered to be in a position to utilise it in enemy interests. There can be little doubt that many a dramatic story in this connection remains yet to be revealed.

From the Italian point of view, however, the "wireless interest" is quite overshadowed by the fact that this Genoese Company, one of the important electrical corporations of the Peninsula, was bound hand and foot to Germany, and the organisation was used to the full against Italy. Owing to scarcity of coal, our ally depends very largely on electrical power for her industries. The tenure by Germans of a predominant interest in this Italian field of enterprise constituted a hidden menace to the vitals of the State that tolerated it. Deliverance from the effects of past pusillanimity is slow and tardy. National efforts all over the world will require to be continued with redoubled energy after the war, both to complete our effacement of the past and to provide against recurrence for the future.

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A Pocket Dictionary of Wireless Telegraphy

Interesting New Publication for Students and Operators

WHAT is an "auto-jigger"? What is meant by "beat reception"? How are "continuous waves" produced? What is a "direction finder"? Such are a few of the questions arising each day in the minds of inquiring students. It is with the idea of answering these and hundreds of other such queries that the Wireless Press, Ltd., have produced the compact little volume* which lies before us as we write. Correctly described as a "Pocket" Dictionary—it fits into the waistcoat pocket with ease—the publication is yet so thorough in its treatment that no term of importance has been omitted. This is a really wonderful achievement considering the advanced stage which radiotelegraphy has now attained.

No more opportune moment than the present could have been found for its publication, seeing that an unprecedented number of men—both in the Services and outside—are now either operating or engaged in mastering the intricacies of this most fascinating of sciences. Any publication which may help to "speed-up" the training of a wireless operator in these anxious times is playing an important part in defeating the submarine menace, for without wireless telegraphy very many of our protective measures would be totally useless. The "Pocket" Dictionary is effective ammunition for helping to defeat the Hun!

The author points out in his preface that his aim has been to produce a "Students' Companion" as well as a dictionary, and for this reason many words have been included which, though not actually "wireless" words, are yet almost sure to be met with in pursuing the study of this subject. Under this heading we should place such terms as "Abscissa," "Amplitude," "Booster," "Daniell Cell," and "Element." The inclusion of such words is undoubtedly wise, particularly in view of the fact that it is always difficult clearly to define the limits of such a subject as radiotelegraphy, which touches upon so large a number of other sciences.

Not only the beginner, but the advanced student, may profitably turn the pages of this handy book, the former finding definitions of simple terms and the latter such information as the chemical composition of the various crystals used for rectification. We specially commend the dictionary to journalists and authors. It will help them to avoid those multifarious pitfalls which beset the path of a general writer when dealing with technical or semi-technical subjects.

The publishers are to be congratulated on the excellent format of the volume, which, with its 160 odd pages bound in rexine, is compressed into small compass without any sacrifice of clearness in printing. The price, too, in these days of expensive production is remarkably low, and only the prospect of very extensive sales can make possible its publication at two shillings.

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* *A Pocket Dictionary of Technical Terms Used in Wireless Telegraphy.* By Harold Ward. London The Wireless Press, Ltd. Price 2s. net.

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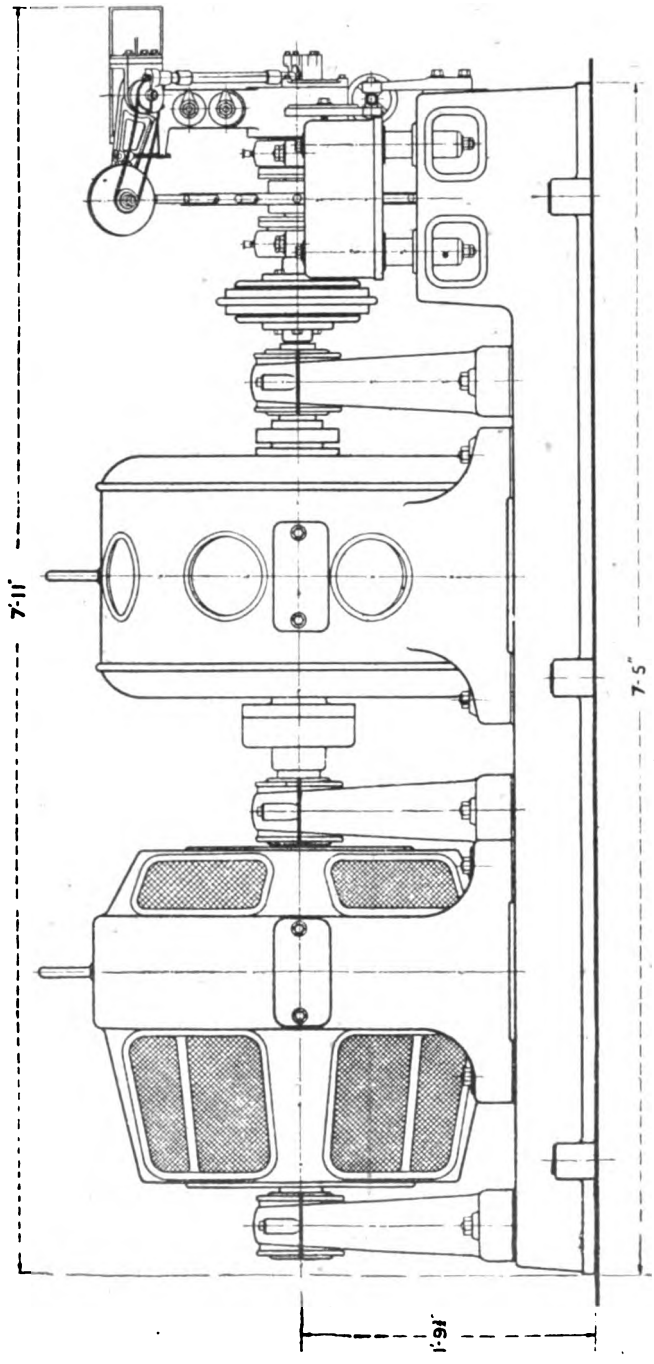

Motor Alternator Disc-

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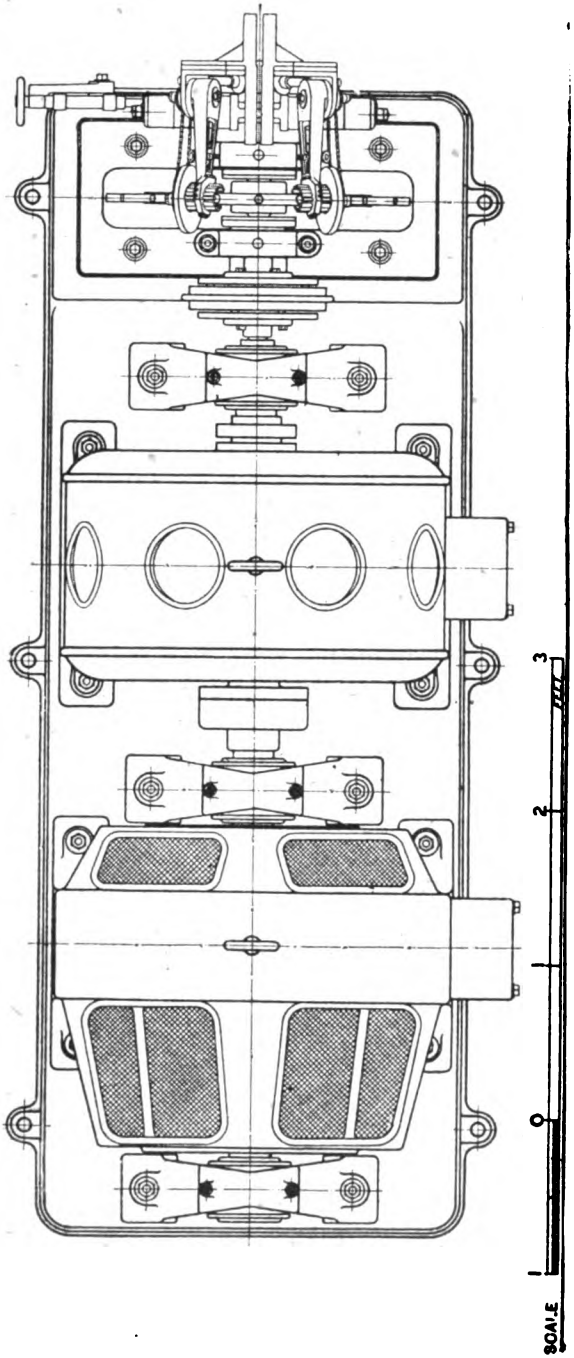

-Discharger Set 30 kw

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The Blown-in Chamber

By PERIKON

THE superiors of Lieutenant McIntyre knew him for a good sapper, and to him they had assigned the task of constructing a fresh battle headquarters whence the staff of his division would control the next leap forward—due at dawn.

The site chosen for headquarters was a row of ruins which lay in the plain, three kilometres west of the objective—a ridge from which the billowing smother of smoke by day, and the flicker and dance of explosive by night, seemed never to lift nor to fade. For three days the guns had hammered it, had seemed to blot it out, had seemed to blow the ridge level with the rest of the dank dreary plain it rose from, yet above the smoke pall the flares and signal lights of the enemy still rose, bursting in clusters of green and red. He was holding, and would hold, till the infantry "went over."

McIntyre toiled with his men till the series of sandbagged shelters was completed; then, with his sergeant, he searched the ruins for a sleeping place. In the endmost ruin they stumbled on the blown-in dugout. The entrance to the shaftway faced the line. This, together with the build and dimensions, told McIntyre the place was of enemy construction. They descended, to find the dugout had been divided into two chambers. The outer was intact, but the entrance to the inner was blocked by a tortured mass of blackened earth and splintered timber. McIntyre wondered vaguely what sort of ghastly tableau lay hidden behind the screen of earth and wood sealing the entrance—what sort of grisly picture would meet his eye, could he pierce the ten-ton shroud of debris. He found himself speculating as to the cause of the explosion. Bombs, hand grenades—either these or a charge of some high explosive detonated from the interior, he told himself. But hang the explosion—he was looking for a sleeping place, not making a report on the thing! The floor of the outer chamber would do. He was so dog-tired that he'd cheerfully have slept in three feet of freezing water. In pushes, when jobs *must* be done, one cannot expect one's usual spell of sleep, nor can one expect hot and regular meals. He'd sleep there till zero. Zero was timed for four the next morning. He'd manage just over three hours, and jolly grateful he'd be to manage even that. He was dead beat. He climbed inside his sleeping bag and lay down. The flicker of the guns capered on the square of timbered wall opposite the shaftway, in vivid sprays of violet green and crimson, half-lighting the place with a weird, uncanny fire, which fluttered and leapt, and lived and died, fitfully, spasmodically, now bright, now dim; and with it, the thunder and throb of the bombardment working up to drum-fire, for it wanted but three hours to zero—zero, the gaunt, dreary hour on the dawn when the blasted country, the barrage, and the mists of the valley, lie ahead—the hour of wild agony, the hour of great calm.

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McIntyre tossed and turned. When would he sleep? Hang the guns and their infernal noise! He'd light a cigarette; perhaps it would better help him doze off.

Suddenly he noticed the ruins were being shelled and being shelled heavily. Still, that was only natural. They were searching for the battery of eighteen pounders he'd noticed camouflaged in front of the ruins. Funny though, they seemed to be concentrating scores of guns on the ground directly overhead. The dugout staggered and swayed, and jumped and lifted, as the shells smashed round it. The sickening reek of explosive wafted in and drifted round in choking eddies. Fragments of chalk and earth trickled through the chinks of the roof-boards in fitful little streams.

Suddenly McIntyre heard someone on the stairway. Someone was descending, seeking shelter doubtless. He turned toward the entrance, and in the leaping half-light he saw an infantryman. The left sleeve of the man's tunic had been cut away, and his arm was swathed in dirty sodden bandages. His bayonet was fixed, and he wore battle order.

He was covered in mud and filth. His face was wild and haggard. He was shouting—looking straight across the inner chamber at the opposite wall, and shouting. He paid no attention to McIntyre's enquiries and challenges, but continued to peer wildly across the dugout. "They're coming—coming!" Then he turned and disappeared hurriedly up the shaftway. McIntyre heard the creak of the man's equipment and the crunch of his boots gradually growing fainter as he mounted the steps.

McIntyre turned, and his eyes caught the opposite wall. Heavens! what had happened? The debris had vanished. He could see right into the inner chamber. He made to raise himself, to ask what had happened. He failed. Something pinned him where he lay. He seemed to be strapped there. His limbs were dead and numb. They refused to obey the messages of his brain. He struggled—struggled till his body was dripping, till his veins stood out on him, but it was of no avail. He was helpless—move, he couldn't. He shouted, shouted till a hoarseness gripped his throat, till his voice became a mere croak; but nobody heard.

The inner chamber was lit by two guttering candles. Below the candles lay a mass of queer, glittering instruments, and varnished cases, which shone and winked at a thousand points in the dim, jumping light. Two men were bending over the apparatus. On their heads some form of telephone was strapped. Telegraph stuff of some sort, evidently. The instruments began to hiss and splutter. McIntyre remembered. He'd seen a similar set before—a trench wireless station, that's what it was. Suddenly the shelling ceased. In its place came the rattle of rifles and machine guns *directly overhead*. Heavens! what on earth was wrong? Some terrible disaster must have overtaken his division. Then other sounds—the sharp, vicious bark of hand grenades, the snap of lead on brickwork—broke on his ears. Again he strained desperately to rise. Again he tried to fight down the Something which held him where he lay. Again he failed. From the ruins above came wild bursts of shouting, the crunch of boots, the thud of blows, groans, blasphemy, and cries, all mingling in a devilish hell-chorus. Then comparative quiet. Suddenly, a shuffling step on the stairway. Someone was descending—descending cautiously.

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He glanced toward the inner chamber. Both men were feverishly packing their instruments. Suddenly there was a report, a vivid crimson flash, and one of the wireless men dropped; dropped in a sprawling heap, and lay strangely quiet and still. His comrade reached wildly for his rifle. "Halt! Halt!"—and with that a hulking figure in sea-grey strode swiftly across the outer chamber. McIntyre saw, by his facings and badges, that he was an enemy captain of infantry, and a Prussian. On his heels came his orderly in fighting kit. The wireless man had no option. He threw up his hands.

The German thrust him aside and glanced rapidly at the instruments. He turned, and spoke at length to the orderly, who saluted and withdrew. Five minutes later the servant returned with another officer whom McIntyre put down as a lieutenant of signals. The newcomer ran over the set in a casual and careless manner. McIntyre could see that parts of the apparatus puzzled him, and that he was loath to confess his ignorance before the Prussian and his wooden-faced servant. He turned to the captain. Evidently the set had been reported in working order, for the Prussian swung round to the operator. "You will send a brief message. We have here your cyphers. Good. Your machine is working. The lieutenant says it. The message will merely ask that intensive fire shall be directed on a certain map square. Yes, your pigdog infantry *are* there—do not jump. It is a great idea, this of mine. What your trash English news sheets should put as 'characteristic German thoroughness.' Here is the message. The station which receives it will know nothing, as it would be simple that you should be overlooked in our advance. Send it."

But the operator did not reply.

"Send it, or I shoot."

Still the man kept silent.

Then the Prussian changed his tactics.

"Come, send it; I myself will ensure that you are well treated."

Still no reply.

"I might even arrange that you should make escape. Come, send it."

"Right," suddenly broke out the operator. "I'll send it."

"Ah, I thought you would," murmured the German.

"Where," asked the operator, picking up the message form, "shall I send it?"

"To the headquarters of your heavy artillery. Be careful to send each letter correctly." And he read over the groups of the message.

"This—X3 N10 K19—is most important. That is the map position by your own maps."

"Very good."

A great disgust surged up in McIntyre. The man was a coward, a craven coward. If he'd had his revolver with him, instead of at headquarters, he'd have emptied the six chambers in the rotten cur. By sending the message he'd perhaps cause the annihilation of an entire brigade. Seemingly, that didn't matter. The man's concern was entirely for his own dirty skin. Well, he hoped the first British shell knocked the waster out. They hadn't much use, nor would the enemy have much use, for such a white-livered skunk.

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"Very good," repeated the operator. "I'll send it." And he bent over the table toward a small varnished case—a small case which was clamped on the table alongside the largest and most important looking of the instruments. The lid flew open. And there, in a row, were five Mills grenades. The pins were connected to a common brass rod. Before the Prussian, or the signal officer, could stay him, the pins were out. There was a wild scream of fear from the captain of infantry, a hideous yell from the servant. The lieutenant flung himself on the floor. The operator did not move. He stood where he was. Next instant there was a thunderous roar, a blinding flash, and the inner chamber vanished in a whirling fog of flying earth and hurrying smoke.

Something flew past McIntyre's head with a hiss, struck the wall, and stayed there, embedded in the wood. He lay stunned and deafened, blinded and dazed, by the concussion, by the flash of the thing. Gad! might he be forgiven his unjust thoughts. The operator was more than a hero. Would that he had half the man's grit, half his gallantry. A great remorse overwhelmed him, a great sadness. He'd been a rotter to think the poor lad a coward—might God forgive him. Suddenly, he told himself, it was getting lighter. The inky blackness of the place was giving way to greyness. Someone was again descending the shaftway. Someone was calling him. He sat up with a start. "Zero, sir," announced his man. Heavens! had he dreamt it then? Could it be? Yes, he'd dreamt it. And what a ghastly, vivid, convincing nightmare it had been! As he dressed, something protruding from the wall scratched the sleeve of his coat. He lit a match, and pulled at the object. It was a splinter of grenade shell, and, adhering to it, a scrap of dirty paper. On the paper was some faint pencilling. He could just make it out. The symbols were: X3 N10 K19—the identical combination he'd heard the Prussian repeat to the wireless man.

A week later, in rest billets, the Divisional Signal Officer made him certain. The place *had* been a wireless station, but it had been lost in an enemy counter-attack almost a month since—that was all "Signals" knew, but McIntyre knew more.

A Lifeboat Idea

In a recent issue of our contemporary, *The Motor Boat*, we notice a suggestion from a correspondent that after the war it may be possible to design and experiment with flying lifeboats, fitted with wireless, which could answer the SOS calls, proceed to the vessel in distress and "report progress." The writer adds that it might be even possible to build a boat strong enough to effect rescues. We sympathise immensely with the first part of the idea; but the second item of the programme rouses scepticism amongst those with some experience of storm rescues at sea.

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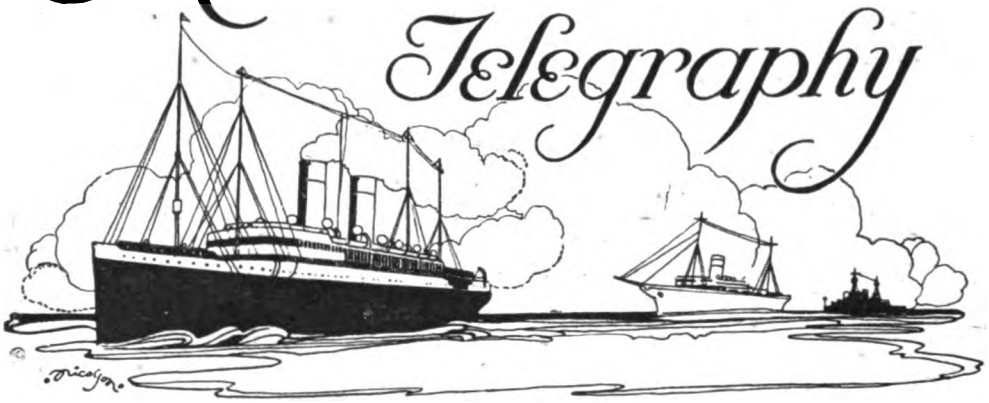
Maritime Wireless Telegraphy



SYNCHRONOUS SIGNALLING AT SEA.

PROFESSOR J. JOLY, of Trinity College, Dublin, one of the Commissioners of Irish Lights, delivered in the earlier part of April the second of his lectures at the Royal Institution, London, on the recent developments and probable lines of progress in synchronous methods of signalling. The lecturer stated that such methods would add considerably to safety at sea, inasmuch as they neutralised the dangers arising from the failure of aerial fog signals.

The method is based on the use of signals propagated in different media, but timed to start at the same instant. The different rates of speed at which such communications travel would, he maintained, be useful to navigation, apart from the ensurance of reception guaranteed by the multiplication of the warnings. All wave-transmission, whether radiotelegraphic, optical, or oral, is liable to encounter "dead areas." The cause of this has never been fully explained, and whilst the precautions recommended by Professor Joly are unexceptionable, the explanation he suggested hardly appears adequate.

He paid a tribute to submarine signalling and wireless telegraphy that (unlike light transmission) neither were affected by weather conditions, and reminded his audience that the submarine bell stroke lagged behind the wireless waves by 1·2 seconds for each nautical mile traversed. Stated briefly, Professor Joly recommended the combination of submarine sound with wireless signalling.

The lecturer gave an interesting account of the employment of wireless telephony for warning ships at sea, taking as his illustration the installation of the Radiophone at Port Judith on the Western approach to Narragansett Bay. This station radiates its name over a considerable distance, and on vessels approaching the danger zone gives a second warning. He maintained that such a scheme of signalling, in conjunction with the wireless compass, would enable the bearing of the signals, as well as the name of the station, to be ascertained, but claimed that the actual distance could only be ascertained by synchronous signalling. The present position appears fully to justify the Professor's pronouncement that "This recent advance, whereby the

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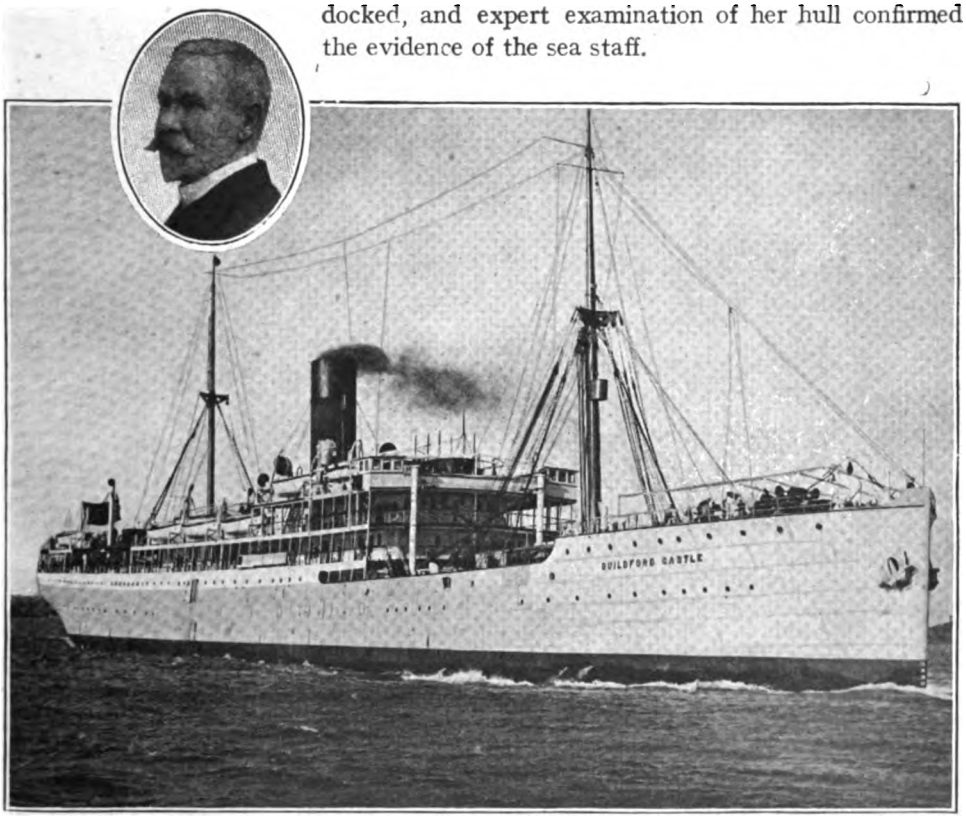
" mariner is addressed in plain language and guided on his way in darkness and in " storm, constitutes an extraordinary achievement, and captures the imagination " beyond any other example of applied science of our day."

HOSPITAL SHIPS.

The attack on the British hospital ship *Guildford Castle*, on March 10th last, constitutes the latest of these particularly dastardly German outrages. There can be no doubt that the German Commander knew the character of the vessel. It was at 5.35 p.m. in clear weather, a Red Cross flag of the largest size was being flown; whilst, in anticipation of night, the navigation lights had been lit and the distinctive marks showing the character of the vessel were brightly illuminated. Moreover, the vessel was passing through an area where, according to the German pledge, such craft (the genuineness and exclusiveness of devotion to whose work of mercy is guaranteed by every imaginable International expedient) should be immune from attack. Two torpedoes appear to have been launched; the first was seen by the Master, Captain T. M. Lang, R.N.R., and a number of his subordinates to " pass close to the ship's " stern from port to starboard." The second struck the vessel abreast of the main mast, but fortunately did not explode. On arriving in port the vessel was dry-docked, and expert examination of her hull confirmed the evidence of the sea staff.



HOSPITAL SHIP "GUILDFORD CASTLE," WITH PORTRAIT OF CAPT. LANG, THE GALLANT COMMANDER (INSET)

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It is impossible to exaggerate the value of wireless on such occasions, and we can assure readers that no achievement of this wonderful science is dearer to the heart of the great Italian inventor and those who have worked with him in its development than the saving of human life. Think of the moral effect alone upon the Captain and all on board produced by the knowledge that aid has been summoned and is near at hand. There were 438 wounded soldiers in transit for "Blighty," and had it become necessary to transfer so large a number of these helpless war victims from their sick beds to small boats, under the short notice and fearful disabilities involved by torpedoing without notice, the amount of suffering and loss of life would have been perfectly heartbreaking. Yet one of the leading German newspapers, the *Deutsche Tagezeitung*, brackets hospital ships with auxiliary cruisers, guard ships and transports, as shipping "which is particularly exposed to and "attacked by the U-boats of Germany."

THE MEDIÆVAL SPIRIT.

How essentially mediæval in mental attitude are the Germans of to-day! I daresay that some readers who found their ideals of the Middle Ages upon the romances which have come down to us, or upon the poems, like Tennyson's "Idylls of the "King," which are modelled thereupon, will exclaim at such a statement. 'Tis our *littérateurs* who are at fault!

The average mediæval "knight and gentleman" was brutal, cruel, and unscrupulous; physically brave yet a bully, and contemptuously overbearing towards the proletariat. Chivalry constituted, not a natural outcome of the mediæval spirit, but a protest against it. We recommend those who take any interest in the matter to read the pages of Froissart and his compeers *critically*.

Of course the picture was not uniformly dark—no true picture ever is. Here and there flashes of chivalrous feeling appear, usually in connection with fighting. We will not labour the details of our generalisation with regard to the relationship between up-to-date Germany and genuine mediævalism—they are fairly obvious to any thinking investigator. But a case illustrating our latter reference found publicity in our daily contemporaries a short while ago, and is worth recording here. The commander of an United States destroyer now in European waters reports in the account of one of his voyages that:

> Nearly every night the commander of this destroyer receives by wireless a message which says:
> "My position is — degrees North and — West. Come and get me, I'm waiting "for you."
> The message is always signed "Hans Rose," and Rose is the name of the German who took a submarine into Newport (U.S.A.) two years ago.
> The American commander has, it is stated, several times rushed his vessel rapidly to the position indicated by the enemy; but "drawn blank."
> "The mysterious wireless message," says the gallant American, "still comes nearly "every night, no matter where the destroyer may be."

This is a "challenge to the lists" conceived in truly mediæval style, and would at first glance appear at variance with the spirit which makes these German submariners jeer at the sufferings they inflict on women and children. The inconsistency is apparent rather than real, and the explanation may be sought on the lines we have indicated above.

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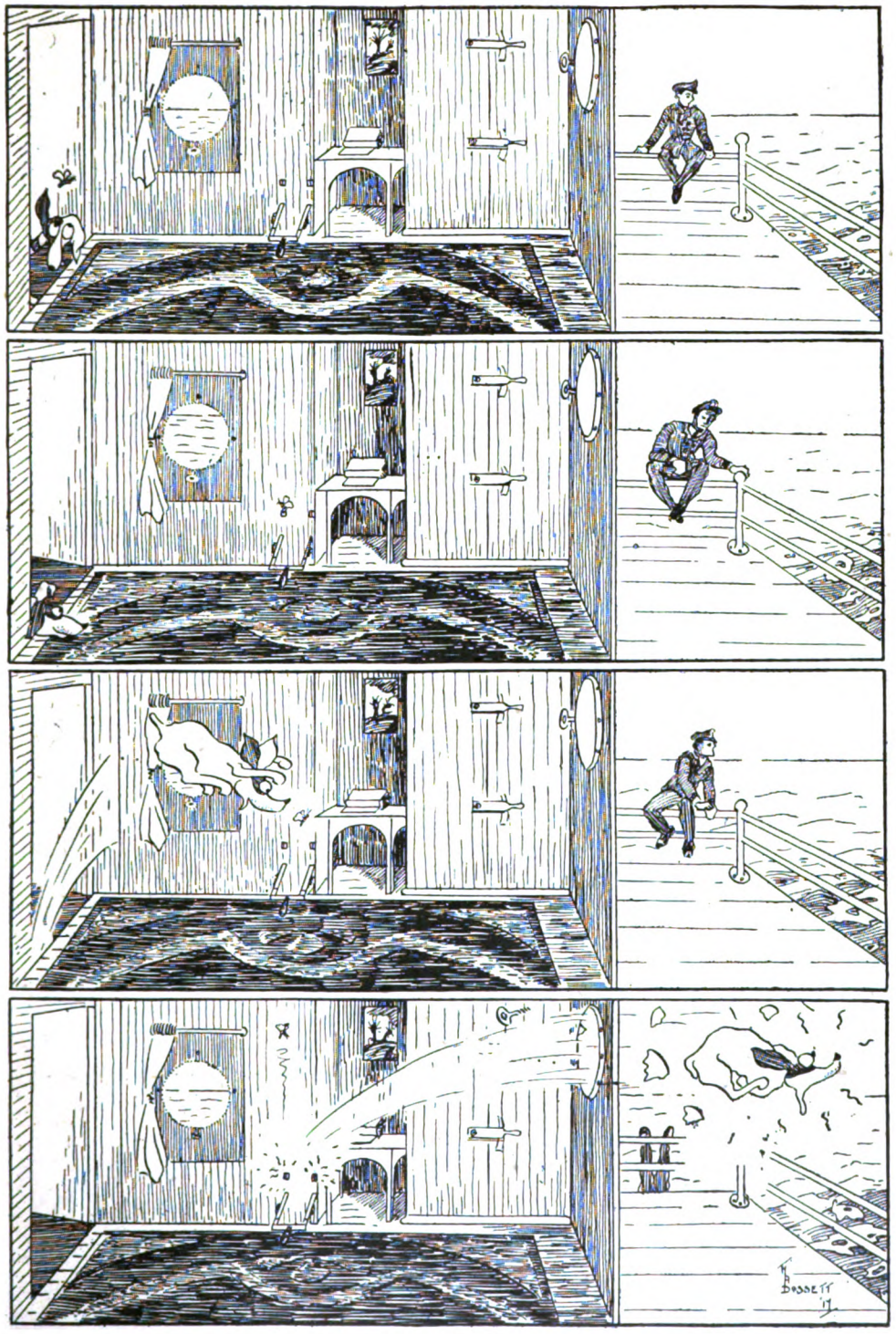
CARTOON OF THE MONTH



THE DOG WATCH.

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An Interesting Legal Decision

The Marconi Wireless Telegraph Company of America v. Emil Simon

A DECISION of considerable importance has recently been promulgated in the action brought by the Marconi Wireless Telegraph Company of America against Emil J. Simon in the Supreme Court of the United States. Briefly stated, the facts of the case are as follows :

In August, 1915, the United States Navy Department accepted a bid by Emil J. Simon to construct twenty-five wireless telegraph transmitting sets. Before the contract, however, was formally completed the Marconi Wireless Telegraph Company of America filed its bill against Simon, seeking an injunction to prevent him from making or delivering the apparatus described in his bid, on the ground that his so doing would be an infringement of the rights secured by the Marconi patents. The matter was taken before the Courts, who refused the injunction on the grounds that by an Act of 1910 the United States possessed a general licence to use patent rights when necessary for its governmental purposes, and that Simon was therefore entitled to make and deliver the articles in question, which action on his part would not be an infringement. The Marconi Company appealed, and again were refused the injunction—the Court of Appeal confirming the decision of the Court below. The further appeal to the Supreme Court, however, resulted in a reversal of the decrees of both the Courts below, and established the principle that—in the United States at all events—the Government have not the power to authorise contractors to construct apparatus under the Marconi, or other patents, without the consent of the patentee. The extent of Simon's liability to the Marconi Company will depend upon the final decision of the Court on the question as to whether the infringement was direct or contributory. The chief point, of course, so far decided is that a contractor with the United States Government stands in the same position as any other infringer, and acquires no immunity because of the fact that he supplies apparatus to the Government.

To "Our" Marconi Operator

THE sentiment contained in the attached lines sent us by the father of a wireless operator will appeal pretty widely in these days of wartime peril at sea :

In your cabin on the deck of a ship far out at sea
You sit and just manipulate a little metal key.
Then the ether waves are started that will spread in circles wide
Till they reach another wireless man across the surging tide ;
If his instrument is tuned aright your message he will read
Just as surely as the written word that most of us would need.
And as you pace the deck at night, or sit " at ease " by day,
You may start a thought-wave when you will to the " Auld Folk " far away !
They will need no apparatus to receive what you would send,
For their hearts are just in tune with yours, and will be to the end !

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Notes of the Month

Shell Shock Apparatus.

Mr. Ernest Elias Greville, a manufacturer of electrical medical apparatus, applied on April 25th last for a licence to take the patented sparkgap of a German wireless apparatus to fit in an instrument he was making for treating shell shock by electricity. The applicant explained to the court that he wanted a high-frequency current, and that the apparatus covered by the German patent gave him just what he desired with a silent working. The Controller of Patents granted the licence on the grounds that "the court existed to assist all useful adaptations "for manufacture, and if the patent specification was limited to wireless it might "be a nice question whether the patent covered use for anything else at all."

The patent in question was No. 6,424, accepted on November 25th, 1909, and constitutes one of the basic patents of the Telefunken wireless system.

The German apparatus secures the production of "rapid but slightly-damped "electrical oscillations," and there are many other methods giving similar results patented (*e.g.*) by Belgian, British and American citizens. Mr. Greville will have to pay to the Comptroller a royalty for the use of the enemy patent, and it is to be presumed that the applicant satisfied himself before making the application that the German device answers his desired purpose better than those fathered by Allied patentees, because it is obviously preferable that such fees should be paid to our own subjects or those of friendly countries, rather than held in trust for an enemy concern.

Chilian Time Signals.

We observe the recent announcement in *Lloyd's List* to the effect that wireless time signals are being sent out by the Hydrographic Office at Valparaiso, commencing at 8 h. 12 m. 13.7 s. Standard Time (corresponding to 12 h. 55 m. 00 s. G.M.T.) and continuing for five minutes. According to an Admiralty notice to mariners (No. 484 of 1918), during this period every tick of the chronometer is transmitted except the 29th second, the last ten seconds of each minute.

Enemy Wireless Companies.

For some time past *pourparlers* have been proceeding between the two German wireless concerns—The Telefunken and the High-Frequency Company—with a view to the conclusion of a working agreement, in order to further the future development of their undertakings. Up to the present we understand no final result has been reached, but the attempt to consummate such a project is significant of Teutonic forethought for the coming of peace.

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Some Curves and Nomograms for Wireless Calculations (III.)

By P. BAILLIE, L.Sc.

NOTE.—*The first instalment of this article appeared in our April issue, p. 41 et seq.*

K ($\lambda\,\lambda'$)=coupling coefficient of coils λ and λ' etc. . . . Factors termed R, S, T, U should then be got from nomogram (Fig. 14) in the following manner:

Join by a straight line values of corresponding diameters recorded on D and D' scales. Join the point where it meets C scale to value of K (as taken from curves, Fig. 2). Read the value of R or S, T, U on the R scale.

Then: $K=\frac{n_1\,n'_1}{\sqrt{L\,L'}}\,.\,[R+S-T-U]$ per cent. — n_1 and n'_1 turns/cm. — L and L' microhenrys.

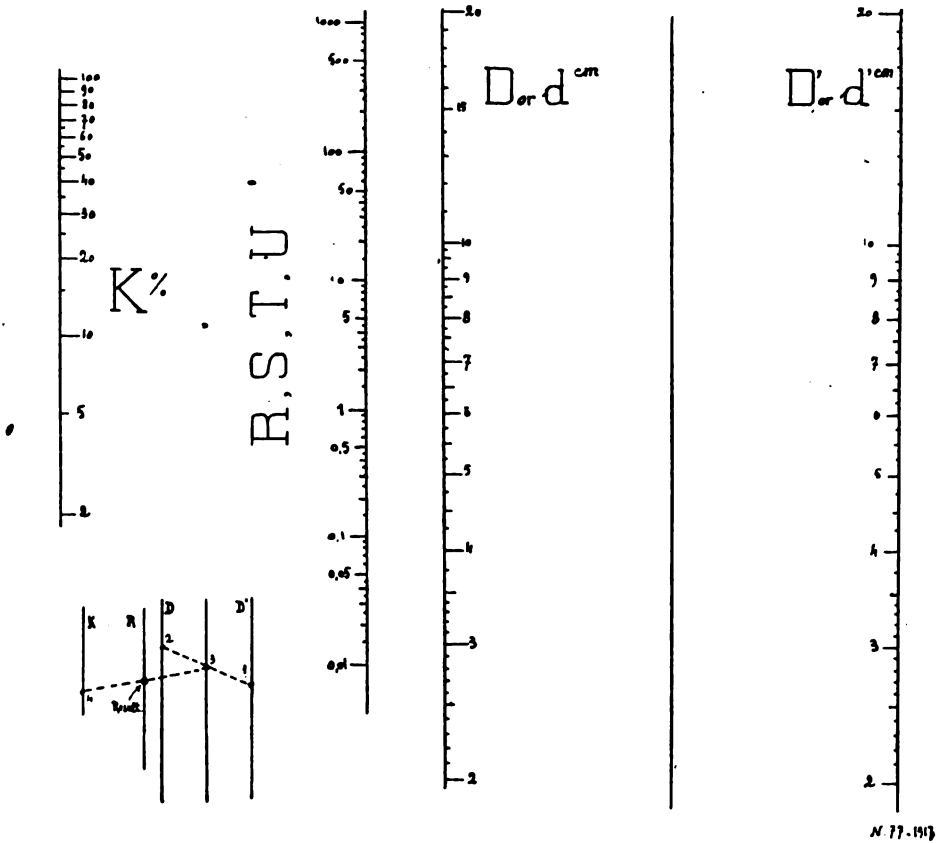

FIG. 14.

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3. *Particular Cases.*—(*a*) When coils have the same dimensions (they may have different windings) $K=\frac{n_1 n'_1}{\sqrt{L L'}} \cdot [R+S-2T]$ per cent.

(*b*) When one of the coils is wound to the centre $K=\frac{n_1 n'_1}{\sqrt{L L'}} \cdot [R-U]$.

Turning now to the oscillating circuit, the power in this circuit is $P_{o.c.}=\frac{P}{\eta}$, η being the efficiency from oscillating circuit to antenna. When there is no data for η, it may be taken as $\eta=\frac{K^2}{K^2+\frac{2}{\pi}(\delta_1+\delta_2)}$ though no great accuracy is to be expected.

K = coupling coefficient.

δ_1 and δ_2: decrements per semi-period of coupled circuits.

The two coupling waves $\lambda=\lambda_0\sqrt{1\pm K}$ may be quickly calculated from nomogram Fig. 15.

It is now a usual practice of making use of transformer primary resonance. Since it does not seem that calculations thus involved are very frequently spoken of in this country, a few details will be given. It is known * that primary current i and potential v are given by:

$$i=-\frac{E_0}{R}(1-e^{-at})\sin \Omega t \qquad \alpha=\frac{R}{2L}$$

$$v=E_0 S(1-e^{-at})\cos \Omega t \qquad S=\frac{1}{R\,\Omega\, a^2 c}=\text{overtension}$$

as pointed out, v should be a maximum when sparking occurs—that is to say, sparking should take place (Fig. 16) at 1 or at 2 or etc. . . . Sparking occurring after k reverses of potential (k=a whole number), the number of sparks per second will be $N=\frac{\Omega}{k\pi}$.

Ω = pulsation = $2\pi \times$ alternator frequency.

Hence sparking potential U is

$$U=(-1)^k \cdot a E_0 S(1-e^{-\frac{k\pi}{2S}}),$$

and primary potential $=E_0 S(1-e^{-\frac{k\pi}{2S}})$.

Power at the spark gap is then $P_{o.c.}=\frac{1}{2} N c a^2 E_0^2 S^2 (1-e^{-\frac{k\pi}{2S}})^2$.

Power taken from alternator is $P_a=N\int_{t=0}^{t=\frac{k\pi}{\Omega}} e i \cdot dt$

e = electro-motive force $=E_0 \sin \Omega t$.

$$P_a=\frac{N E_0^2}{R}\int_0^{\frac{k\pi}{\Omega}}(1-e^{-at})\sin^2 \Omega t \cdot dt$$

* See THE WIRELESS WORLD, August 1917. The same notations will be used.

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integrating and accounting for resonance condition $La^2 c \Omega^2 = 1$.

$$P_a = \frac{N E_o^2}{R}\left[\frac{k\pi}{2\Omega} - \frac{S}{\Omega}\left(1 - e^{-\frac{k\pi}{2S}}\right)\right].$$

The efficiency ρ of feeding circuit is then

$$\rho = \frac{P_{o.c.}}{P_a} = \frac{S\left(1 - e^{-\frac{k\pi}{2S}}\right)^2}{k\pi - 2S\left(1 - e^{-\frac{k\pi}{2S}}\right)}$$

This is the case of a transformer without losses or magnetic leakage. The transformer efficiency, y, when there are losses and leakage has been considered by the author in the August 1917 issue of this magazine. The reader should refer to the quoted article for values of y. Total efficiency from alternator to spark gap $= \rho y$

Curves Fig. 17 give values of ρ in terms of S for different values of k. It should be noted that ρ is a maximum when $k = 1$; *i.e.*, when the spark note is

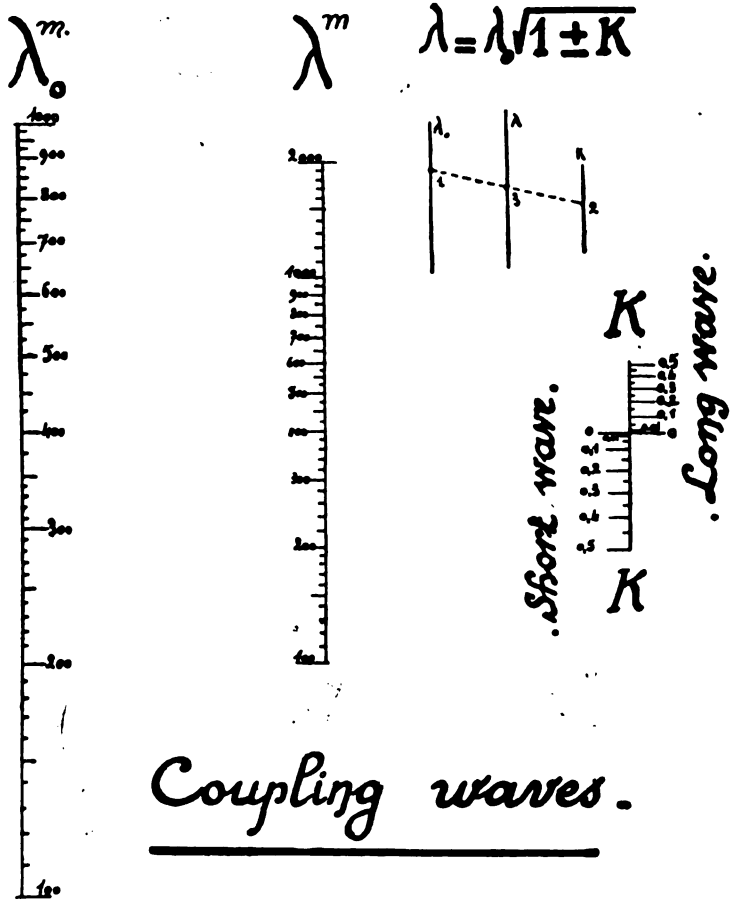

FIG. 15.

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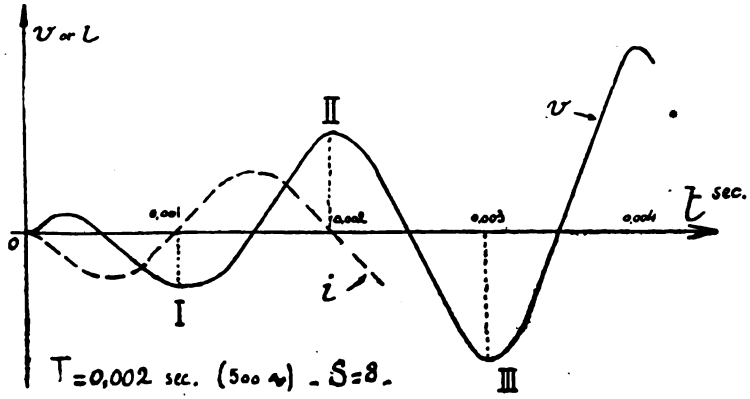

FIG. 16.

twice the alternator frequency as is the case with Marconi synchronous dischargers.

The power $P_{o.c.}$ at the spark-gap is imposed. The capacity c of the condenser is given by $c=\frac{2P_{o.c.}}{NU^2}$; U has to be assumed accounting for insulation and dielectric losses. The maximum of the electro-motive force of the alternator is then

$$E_o=\frac{U}{aS\left[1-e^{-\frac{k\pi}{2S}}\right]}.$$

The transformation ratio, a, and overtension, S, have to be chosen according to the preceding formula (for instance, S may be from 6 to 8). Or E_o and S may be assumed, and a thus be chosen such as giving a suitable value to U.

Moreover, the current in the oscillating circuit

$$I_{R.M.S.}=\frac{1{,}885\,.\,U_{R.M.S.}\text{ (volts)}}{\lambda\text{ (metres)}}\,.\,e^{-\frac{\delta}{2}}\,.\,c\text{ (mfds.)}\ \#\ \frac{1{,}885\,.\,U_{R.M.S.}\text{ (volts)}}{\lambda\left(1+\frac{\delta}{2}\right)}\,.\,c\text{ (mfds.)}$$

should not be so high as to damage the discharger. H.F. resistance of the connections may be calculated by ordinary formulæ or by a nomogram given in October 1916 issue of this publication.

The inductance of the oscillating circuit is given by Thomson formula :

$$\lambda\text{ (meters)}=1{,}885\,\sqrt{l\text{ (mhys.)}\quad c\text{ (mfds.)}}.*$$

The resistance and total inductance of primary circuit are :

$$R=\frac{U^2}{2\pi kSa^2P_{o.c.}}\qquad L\,\Omega=RS.$$

R is the sum of alternator, circuit, and adjusting rheostat resistances. L is the sum of alternator and adjusting coil inductances, and of inductance $\frac{L'}{a^2}$ equivalent

* See THE WIRELESS WORLD, February 1917.

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to secondary inductance L' (choking coils). The alternator has to be designed in order to give at a frequency $f=\frac{kN}{2}$ ♯ a R.M.S. electro-motive force

$$E_{\text{R.M.S.}}=\frac{U}{aS\sqrt{2}\left[1-e^{-\frac{k\pi}{2S}}\right]}$$

and a current

$$I_{\text{R.M.S.}}\text{ (amp.)}=\sqrt{\frac{P_{o.c.}\text{ (watts)}}{R\text{ (ohms.)}}}\left(\frac{1}{\rho y}-1\right)$$

Its power is

$$\frac{P_{o.c.}\sqrt{\left(\frac{1}{\rho y}-1\right)\pi kS}}{aS\left[1-e^{-\frac{k\pi}{2S}}\right]}$$

(P in $kw.$; Power in kilovolts-amperes)

Curves Fig. 18 give values of $S\left[1-e^{-\frac{k\pi}{2S}}\right]$ which may be needed in previous calculations.

In designing the alternator and the transformer it should be kept in mind that the frequency is high compared with commercial alternating currents. The losses are then more considerable. When heavy losses cannot be allowed, particular attention should be paid to lamination and to transformer windings as already indicated when dealing with y.

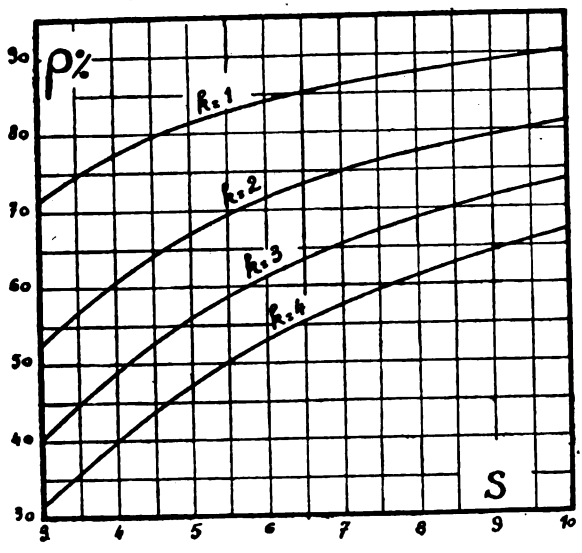

FIG. 17.

Since the primary resonance may accidentally not be obtained, it is good to give to the alternator a power somewhat larger than the calculated power.

The calculations involved by the design of the receiving part of a wireless station chiefly refer to inductance and capacity. The receiving antenna being given, means are to be provided for its tuning on all desired wave-lengths. The usual ways of inserting in the antenna circuit a condenser, an inductance, or both in parallel, have already been dealt with, as well as determination of "steps."*

* THE WIRELESS WORLD, February and September 1917.

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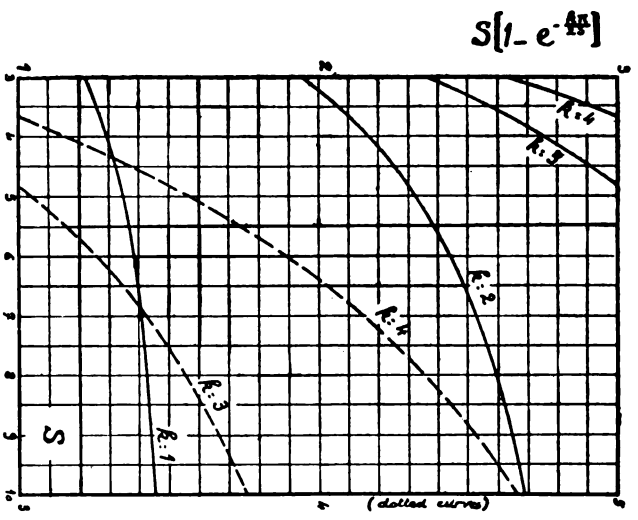

FIG. 18.

There is nothing new to be said about the design of the detector circuit, whether it be oscillating or aperiodic, directly coupled to the antenna circuit, or by means of a low resistance oscillating circuit. The capacity and inductance have only to be designed with regard to the nature of the detector (current or potential detector, etc. . . .); especially a large proportion of inductance has to be secured when three electrodes, valves, amplifiers, or detectors are to be used. Reference has already been made to the coupling of the circuits. The advantage of using flat spiral coils, especially of coils wound to the centre, or nearly so, should be pointed out, as the calculation of coupling coefficients is comparatively easy, and moreover such coils do not of themselves possess a large capacity. This applies to sending inductances as well as to receiving ones. Where compactness is required, flat coupled coils are very suitable; curves (Fig. 13) are then useful.

For instance, it may be found that the receiver oscillating inductance, calculated by Lieut. Bertram Hoyle (Vol. V., page 265), may be composed of four flat coils 10 cm. in diameter, separated by 1 cm., and wound to the centre with $\frac{50}{100}$ of m/m wire ($n_1=18{\cdot}6$).

The steps may be:

50 mhys. : at 2·8 cm. from centre of first coil.
200 mhys. : at 4·4 cm. from centre of first coil.
555 mhys. : at 7·7 cm. from centre of second coil.
3,405 mhys. : at end of fourth coil.

This would form a block 10 cm. in diameter and 4 cm. thick. A cylinder of same diameter and inductance would have 14 cms. in length. This calculation required but half an hour; this is a simpler matter than using the trial method of building a model.

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Among the Operators

It is our sad duty, month by month, to record the deaths of the brave operators who have lost their lives at sea by enemy action, and other causes, in the wireless service of their country. Owing to the necessity of preventing the leakage of information likely to assist our adversaries, the names of ships and localities of action cannot be published. With the exception of Mr. H. A. Marshall, whose death took place in hospital at Newport News, U.S.A., the lives of the operators mentioned this month have been sacrificed as the result of hostile activities. Both on our own part, and on that of our numerous readers, we extend to the parents and relatives of these young men, who so nobly uphold the "wireless tradition," the deepest sympathy in their sad bereavement.

Mr. Herbert Anthony Marshall, who died in hospital from illness at Newport News, U.S.A., on February 14th last, was born at Courett, Durham, January 10th, 1899, and educated at St. Cuthbert's College, Ushaw. He was trained at the North-Eastern Schools of Wireless Telegraphy, Newcastle-on-Tyne, and after gaining the P.M.G. Certificate, appointed to the Marconi Company's staff in July, 1917.

Born at Dumfermline, on April 24th, 1900, Mr. Robert Black Duffin was educated at Winchburgh Public School, and trained at the North British Wireless Schools, Ltd., Edinburgh. He received the P.M.G. Certificate, and was given an appointment by the Marconi Company last January.

Mr. Roland Walter Falconer was born at Arbroath, on February 4th, 1899, and went to the St. Paul's and to Dudhope School, Dundee. Commencing his career with Messrs. D. and J. Tullis, engineers, Clydebank, he subsequently attended the North British Wireless Schools, Ltd., Glasgow, and obtained the P.M.G. Certificate. Mr. Falconer's service with the Marconi Company started in December, 1916.

Of Irish birth, Mr. John Joseph Callaghan was twenty-four years old, and born at Knightstown, Co. Meath. He received his education at St. Finian's College, Mullingar, St. Kieran's College, Kilkenny, and at St. Joseph's Seminary, Leeds. His specialised training he received at the Atlantic Wireless College, Cahirciveen, where he gained the P.M.G. Certificate.

Mr. Callaghan was appointed to the Marconi Company's staff on October 22nd, 1916.

Mr. Michael McElligott was born at Lerrig, Co. Kerry, on August 18th, 1897. He was educated at Ardfert, and trained at the Atlantic Wireless College, Cahirciveen, where he qualified for the P.M.G. Certificate, and was placed on the staff of the Marconi Company on August 24th, 1915.

Woolwich was the birthplace of Mr. Albert Edward Dallibar seventeen years ago. After receiving his education at the Raines Foundation School, London (during which period he was awarded the Royal Life Saving Society's Certificate

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ROLL OF HONOUR.

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and badge), he was trained at Marconi House School. In January last, immediately after winning his P.M.G. Certificate, he joined the operating staff of the Marconi Company.

Mr. Thomas McKinnon Dilly, born at Arbroath on August 8th, 1901, was educated at Abbey Public School, Arbroath, and started his career by joining the staff of the co-operative society of that city. His wireless training was received at the North British Wireless Schools, Ltd., Dundee, and—on receipt of the P.M.G. Certificate in December, 1917—he proceeded to sea in the Marconi Company's service.

Mr. William David Jones was born on November 9th, 1897, at Dangendirne, Wales, and received his education at the Elementary School. After completing the curriculum there he entered the service of a coal mining company, subsequently leaving their employment to take up wireless as a career. Trained at the South Wales Wireless College, Ltd., Cardiff, Mr. Jones qualified for the P.M.G. Certificate, and entered the service of the Marconi Company on March 12th, 1916.

Born on September 18th, 1900, at Bibury, Gloucestershire, Mr. Leonard Alfred Brasington was educated at Cirencester Grammar School, and trained in wireless telegraphy at Marconi House School.

After obtaining the P.M.G. Certificate Mr. Brasington joined the Marconi Company's staff on January 13th of this year.

Formerly with Mr. Langhorne, draper, of Pontefract, Mr. Thomas Towler was born at Hunslet, Yorkshire, on May 6th, 1890, and educated at the Bewerley Street, Leeds, and Stourton Board Schools. He took a course of training at the North Eastern Schools of Wireless Telegraphy, Leeds, and received the P.M.G. Certificate.

Mr. Towler entered the Marconi service in June, 1915.

A Youghal man, Mr. Thomas Flavin was born at Pilmore on November 14th, 1898, and received his education from the Christian Brothers. He was a student at the Irish School of Telegraphy, Cork, and qualified for the P.M.G. Certificate, being placed on the sea-going staff of the Marconi Company on January 1st, 1917.

Mr. William Dunn Burgess was born on April 13th, 1898, at Montrose, and attended the North Links and the Townhead Supplementary Schools there. For a time he was employed by Messrs. J. Selby & Co., tailors, Montrose, after which he received a training in radiotelegraphy at the North British Wireless Schools, Ltd., Dundee. On gaining the P.M.G. Certificate, Mr. Burgess was placed on the Marconi operating staff on March 26th, 1916.

A CORRECTION.

The late Mr. W. E. Pinder was trained at the City School of Wireless Telegraphy, Ltd., Manchester; not, as erroneously stated in the May number, at Marconi House School.

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Instructional Article

NEW SERIES (No. 3).

EDITORIAL NOTE.—Below we give the third of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

FORCE (*continued*).

Angular Velocity.—Having dealt with velocity considered as the rate of displacement it is appropriate to explain at this point Angular Velocity, an important quantity with which the reader will often meet in his study of wireless telegraphy and related subjects. In reference to Fig. 12 let us assume that the point *O* is fixed and that the line *OP* revolves about it in a certain plane. In this case we will let the plane be that of the paper. If the line *OP* completes 120 revolutions every minute its Angular Velocity is 120 r.p.m. or 120/60 r.p.sec. Angular Velocity may or may not be uniform but we shall only refer to uniform Angular Velocity as the student is not likely to be concerned with cases of angular acceleration. Angular Velocity may be either clockwise or counter-clockwise in direction, the latter usually being considered as a positive direction and the former as a negative direction.

Another method of measuring Angular Velocity is to determine **the angle swept out in unit time.** If the line *OP* makes 120 r.p.m. this is equal to 2 r.p.sec.; that is to say, it sweeps out an angle of 360° twice every second, an Angular Velocity of 720° per second. Moving at this velocity in a positive direction the line *OP* will have reached in one-eighth of a second the position OP^1 and will have *swept out* an angle of 90°; this angle is the **Angular Displacement** for that particular instant. In one-fourth of a second the line *OP* will have reached the position OP^2, the angular displacement for that instant being 180°; in three-eighths of a second it will have reached the position OP^3, the angular displacement being 270°, and in half a second it will have reached its starting position *OP*, having in that amount of time swept out 360°. Angular displacement is generally denoted by the Greek letter θ (Theta).

Instead of expressing Angular Velocity in revolutions per minute or degrees per second it is far more usual to state **the number of radians swept out in unit time** by the radius *OP* or its analogue. The student already knows that **a radian equals 57·3°** and that **the circle contains 2π radians.**

NOTE.—A radian (57·3°) *is the angle which is subtended at the centre of a circle by an* **arc** *of the circle equal in length to the radius of the circle*—i.e.,

$$\frac{\text{Circumference}}{\text{Radius}} = \frac{6{\cdot}2832}{(\text{or } 2\pi)}, \text{ and } \frac{360^\circ}{6{\cdot}2832} = \frac{57{\cdot}3^\circ}{(\text{or 1 radian})}.$$

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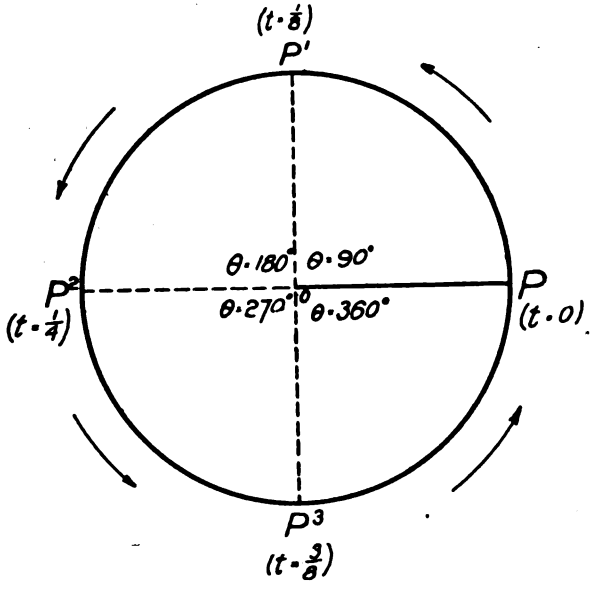

ω=720° per sec.

FIG. 12.

If the rate of revolution is known, then to express Angular Velocity in Circular measure (radians per second) all we have to do is to multiply this rate (in seconds) by 2π.

EXAMPLE.—A wheel revolves at 600 *r.p.m. What is the Angular Velocity?*

$$600 \text{ r.p.m.} = \frac{600}{60} \text{ r.p.sec.} = 10 \text{ r.p.sec.}$$

Each of these revolutions equals 360°, and as each 360° equals 2π radians, $10 \times 2\pi =$ Angular Velocity in radians per second.

That is, $10 \times 6{\cdot}2832 =$ 62·832 radians per second.

In electrical engineering Angular Velocity is always understood to be expressed in radians unless otherwise specified, and is denoted by ω. If n=revs. p. sec., then $\omega = 2\pi n$. The Angular Displacement at any instant, t, is given by the formula, $\theta = 2\pi nt$, where t is the time which has elapsed since the revolutions commenced—*i.e.*, since $t = 0$.

EXAMPLE.—A wheel revolves at an uniform velocity of 1,440 *revs. p.m. What will be the Angular Displacement a tenth of a second after it starts?*

$$\text{Frequency, } n, = \frac{1{,}440}{60} = 24 \text{ r.p.sec.}$$

Angular Velocity, $\omega = 2\pi \underset{(n)}{24}$; and as this is the number of radians swept out per second the question is resolved into this: If 2π 24 radians are swept out in one second how many are swept out in $\frac{1}{10}$ second?

Obviously in $\frac{1}{10}$ second, $\theta = 2\pi \underset{(n)}{24} \times \underset{(t)}{\frac{1}{10}} = 2\pi \times 2{\cdot}4 = 15{\cdot}07968$ radians.

Hence θ in degrees $= 15{\cdot}07968 \times 57{\cdot}3 = 864°$.

Knowing the Angular Velocity it is easy to find the **Linear Speed** of the point P in Fig. 12 as it travels round the circumference. By mensuration, circumference equals $2\pi r$, so that if n be the frequency, the point P covers a distance equal to $2\pi rn$ every second. We have, however, already seen that $\omega = 2\pi n$, so that in the expression $2\pi rn$ we can cut out $2\pi n$ and write ω in its place. Thus the **linear speed** of the point P is ωr—that is, Angular Velocity multiplied by the length of the radius, and is usually expressed in feet per second. To find out how many feet P travels in a given time we must multiply ωr by t.

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EXAMPLE.—A wheel 8 feet in diameter revolves at 120 r.p.m. What is the linear speed of a point on its rim?

$$\omega = 2\pi n = 6{\cdot}2832 \times \frac{120}{60}$$

(2π) (n)

Linear speed $= \omega r$ ft. per sec.

$$= 6{\cdot}2832 \times \underbrace{\frac{120}{60}}_{(\omega)} \times 4$$

(r)

$= 50{\cdot}26$ ft. per sec.

When we come to consider Harmonic Motion the reader will find that an instant appreciation of the relation between Angular Velocity and Angular Displacement and of the way in which they are calculated will be extremely useful to him. It is important to remember that ω stands for a certain *rate* dependent only upon n, to which it is directly proportional.

$\omega \propto n$, or, $\omega = kn$, k being a constant—viz., 2π.

For a given value of ω, θ is a quantity dependent upon the value of t at any given instant and varies directly as t. If we select two instants, say half a second and one second after the motion commences, it is clear that ω will be the same at both instants, whereas θ will be twice as great when $t = 1$ as when $t = \frac{1}{2}$.

For a given value of ω, $\theta \propto t$, or, $\theta = kt$, k being a constant—viz., $\underset{(\omega)}{2\pi n}$.

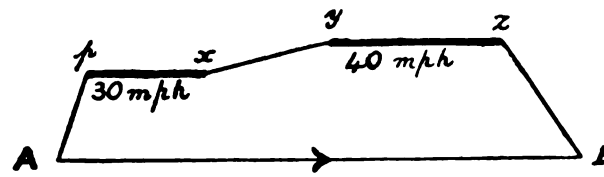
Acceleration.—Reference to Fig. 13 (which is Fig. 11 reproduced) shows that from A to p and from x to y the velocity of the train is increasing, whilst from z to B it is decreasing. **The rate at which velocity changes is called Acceleration.** When used in everyday speech the word acceleration generally signifies increase of velocity and one might be apt to think that in the case of a *decreasing* velocity there is the reverse of acceleration, whereas by the scientific meaning of the word there is true acceleration because the velocity is changing. Acceleration means the **rate of increase or decrease of velocity.**

EXAMPLE.—A body moving in a straight line has a velocity of 20 cms. per sec. This velocity changes and after ten seconds becomes 50 cms. per sec. What is the acceleration?

In ten seconds velocity increases $(50 - 20) = 30$, cms. per second.

Therefore in one second velocity increases $\frac{30}{10} = 3$ cms. per second.

Thus in this example the velocity increases by 3 cms. per second *every second*: this rate is the acceleration, which is written 3 *cms. per second per second, or* 3 *cm./sec.*^{2} From the expression 3 cm./sec.^{2}



60 miles / 2 hours } Average velocity, 30 m.p.h.

FIG. 13.

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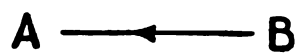
it is a simple matter to see that the *dimensions* of Acceleration are $\left[\frac{L}{T^2}\right]$ or $[LT^{-2}]$, because we divide a *velocity*, in this case 30 cms. per second, by *time*, in this case ten seconds, in order to find Acceleration. Now, the dimensions of velocity are $\left[\frac{L}{T}\right]$, and dividing this by $[T]$ we get $\left[\frac{L}{T}\right]\times\frac{1}{T}=\left[\frac{L}{T^2}\right]$ or $[LT^{-2}]$.

The C.G.S. unit of Acceleration is 1 cm./sec.^{2}.

NOTE.—The reader may need to be reminded that $\frac{L}{T^2}$ *can be written* LT^{-2}, *because a negative power is equal to the reciprocal of the corresponding positive power. Thus* $4^{-2}=\frac{1}{4^2}$, *and in general,* $x^{-n}=\frac{1}{x^n}$.

Acceleration, like Velocity, is a vector quantity. Fig. 14 represents an acceleration of 10 cm./sec.^{2} acting along the line *AB towards A*, the scale chosen being 1 in. = 10 cm./sec.^{2}. If the *sense* of this vector—*i.e.*, *towards A*—be considered as positive, then the reverse sense would be negative. This distinction provides us with a means of representing acceleration as an increase or decrease of velocity, or, in a case where the magnitude of the velocity remains constant but its direction changes, of representing this change.



Scale: 1 in. = 10 cm./sec.^{2}.
FIG. 14.

In this connection it should be noted that as velocity is a vector quantity acceleration occurs if velocity changes in magnitude *or direction*. For example, the velocity of the flow of water through a pipe may be increased or decreased by increasing or decreasing the head of water; in either case the change in velocity is one of *magnitude*. If the water is allowed to flow along a part of the pipe containing a bend, then (1) Acceleration occurs at the bend, and is dependent upon the angle of the bend; (2) Acceleration occurs after the bend is passed, on account of the change in the *direction* of velocity. The student will find it advantageous to think out this and similar cases and to make a separate study of Vectors.

FORCE (*continued*).

It will be recalled that we defined force as the cause of the starting or stopping of uniform motion in a straight line. In the light of the foregoing explanation of Velocity and Acceleration the student will now see that to produce acceleration force has to come into play, because an acceleration is a change from uniformity (of motion in a straight line) to non-uniformity. Now, it is a matter of common experience that there is a close relationship between the *mass* (or *weight*) of a body, the force applied, and the resultant acceleration of the body; in order to move a 10 lb. weight a distance of a foot in one second, one has to exert a greater force on it than would be required to move a 1 lb. weight over the same distance in the same time. Also, the force necessary to move the 1 lb. weight one foot in one second is less than that required to move the same weight over a distance of one foot in half a second. To reduce these ideas of the relationship of force,

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mass and acceleration to a more scientific shape we must briefly consider the three fundamental laws of dynamics which were formulated by Newton.

Newton's First Law of Motion.—Every body continues in its state of rest or of uniform motion in a straight line unless compelled by forces to change that state. As it embodies the facts of experience this law scarcely needs amplification. In speaking of a " state of rest " we mean that the position of the body in relation to surrounding objects is unaltered. Actually there is no *absolute* rest in nature, for a seemingly still body is moving in space, sharing in common with the whole earth the dual motion of that planet, and at the same time its component particles are engaged in ceaseless complex movements at great speeds. So long as the x, y and z co-ordinates of a point (*see* p. 59, WIRELESS WORLD, March) remain the same the point is in a " state of rest." In the case of a body resting on the ground we may say that a point in it which is determined by its position relative to some point on the ground will maintain that position for ever unless force is applied to the body to a degree sufficient to overcome the inertia of the body and the resistance due to friction.

Newton's Second Law of Motion.—Rate of change of momentum is proportional to the applied force and takes place in the direction in which the force acts. If a ton weight and an ounce weight are taken together to a height and released simultaneously so that each falls freely they will reach the earth at the same time. If a piece of lead and a feather are put into a bell-jar which is then exhausted of air * it is found that the feather will fall from one end of the jar to the other as fast as will the piece of lead. In fact, all bodies at the same place fall freely with equal accelerations. Now, the force which produces the acceleration of a falling body may be said to be the *weight* of the body, which, it should be recollected, is proportional to the *mass* of the body so that if two bodies fall with equal accelerations it is not difficult to see that **the forces required must be proportional to the masses**—*i.e.*, $F \propto m$.

It can be proved experimentally that **the force which must be applied to a given mass is proportional to the acceleration required**—*i.e.*, $F \propto a$. Hence we can sum up the two laws by saying that the force required is jointly proportional to the mass and the acceleration and is measured by the product of these two quantities—*i.e.*, $F = ma$.

Let us take the case of a mass, m, at rest and suppose that a force, F, be applied to it, producing an acceleration, a, the velocity at the end of t seconds being v. It has been shown earlier in this article that Acceleration, a, is found by dividing Velocity by Time.

$$a = \frac{v}{t}.$$

So that if in the equation $F = ma$ we write $\frac{v}{t}$ instead of a we get

$$F = \frac{mv}{t}.$$

* In order to remove the factor of air resistance so that they can " fall freely."

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The product mv is called the **momentum** of the body and may be regarded as the *quantity of motion*, a definition which is somewhat vague but which we will now try to make clearer. When the velocity is zero obviously the quantity of motion is zero but becomes mv after t seconds have elapsed; hence, if in t seconds the body acquires a momentum of mv, the momentum acquired *per second* must be $\frac{mv}{t}$. It has above been proved that $F=\frac{mv}{t}$, and we can, therefore, say that the applied force is numerically equal to the rate of change of momentum. The applied force, the acceleration and the momentum are vectors quantities having the same direction and sense.

From the fact that momentum is equal to the product of mass and velocity the dimensions of momentum are easily found.

$$\text{Mass} \times \text{Velocity} = \left[\frac{ML}{T}\right] = \text{Momentum} = MLT^{-1}.$$

Newton's Third Law of Motion.—To every action there is an equal and opposite reaction. This law, as stated in these very general terms, is a little difficult to understand until one thinks about it in the light of a simple example, for at first there is a natural tendency to suppose it to mean that every physical action is undone, as it were, or nullified by an equal action opposite in effect or direction. If such were actually the case every system would be in either a state of equilibrium or of oscillation, which would mean that either no physical work could be done or that the sum total of available energy would remain constant, two conclusions which are opposed to facts. Clearly we must seek to explain the law on other lines.

The simplest case we can take is that of the mutual attraction between two bodies of unit mass, A and B. A attracts B with a certain force, but B at the same time attracts A with an equal force opposite in *sense*. The result is that A and B tend to move together with a force determined by the inverse square law.

Again, in the case of a man pulling a truck along level ground, the force which the truck exerts on him is equal and opposite to the force he exerts on the truck. Why, then, do both move? First of all it must be borne in mind that it is the *system*, comprising both man and truck, which moves; *none of the components of the system moves relatively to the other*. Also it should be noted that when two equal and opposite forces act on a body the latter, if at rest, remains in that condition, and if moving, continues to move without acceleration. In the system with which we are dealing the two internal forces balance each other and therefore do not affect the motion of that system. Now, the man experiences two forces, the backward pull of the truck and the forward forces arising from the action between his feet and the ground. If these forward forces are greater than the backward pull the man will move forward. As regards the truck, this is subjected to forward force exerted by the man and to the resistance of friction. If the force due to the man is greater than the retardation due to friction the truck will move forward. The *mutual action between the man and the*

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truck consists, as explained above, of equal and opposed forces, that due to the truck being exerted by virtue of its inertia. There are four agents—viz., two which may be considered as *external* forces: (1) The reaction of the ground on the man's feet; (2) the retarding forces of resistance; and two which may be regarded as *internal* forces: (1) The man's forward pull on the truck; (2) the truck's backward pull on the man. The internal forces balance each other, so that our example resolves itself into a contest between the external forces. If it is a good road it will be easy for the man to move the truck along; if it is a bad road—*i.e.*, much resistance—the man will be compelled to press very hard with his feet in order to produce the required acceleration. This is a matter of common experience for anyone who has pulled a truck over bad ground.

Units of Force.—From the equation $F=ma$ we arrive at the *dimensions* of force, by substitution. Acceleration, a, being $[LT^{-2}]$ we can write $[F]=[MLT^{-2}]$ = Mass × Acceleration.

The absolute unit of force in any system is that which, if applied for *unit time*, will give a body of *unit mass* a velocity of *unit length per second*. Under the C.G.S. system the unit of force is called the **dyne** and is defined as that force which will impart to a mass of 1 gram an acceleration of 1 cm./sec.^{2}, or, in other words, that force which if applied for one second to a mass of 1 gram will give that mass a velocity of 1 cm. per second.

The **poundal** is known as the **British absolute unit of force,** and is that force which applied to a mass of 1 lb. will give it an acceleration of 1 ft./sec.^{2}.

The increase per second in the velocity of a body falling freely is, in England, 32·2 ft. per second, which is another way of saying that the uniform acceleration of a freely falling body is 32·2 ft./sec.^{2} or (C.G.S.) 981 cm./sec.^{2}. Thus a mass of 1 gram will fall with an acceleration of 981 cm./sec.^{2}. But a force of one dyne will impart to a mass of 1 gram an acceleration of 1 cm./sec.^{2}; *therefore a force equal to the weight of 1 gram equals* 981 *dynes*. Similarly, a force equal to a weight of 1 lb. equals 32·2 poundals.

(*To be continued.*)

Share Market Report

LONDON, *May 10th*, 1918.

A QUIET tone has ruled in the Industrial Market during the past month. Notwithstanding the unfavourable conditions the shares of the Marconi group have shown a marked firmness, with considerable investment buying. The closing prices as we go to press are: Marconi Ordinary, £3 3s. 9d.; Marconi Preference, £2 12s. 6d.; American Marconi, £1 3s. 3d.; Spanish and General Trust, 9s.; Canadian Marconi, 10s.; Marconi International Marine, £2 8s. 9d.

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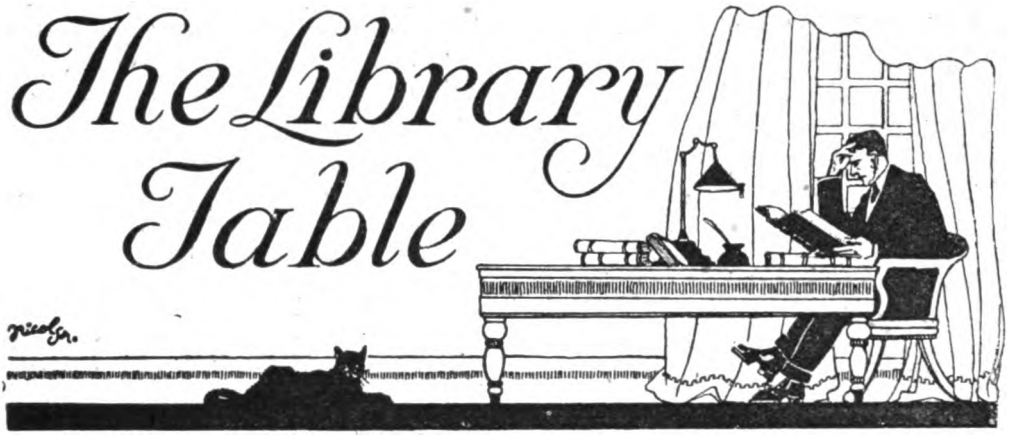

SUBJECT INDEX TO THE PERIODICALS, 1916—DATED APRIL, 1918.

Published by the *Athenæum* at the request of the Council of the Library Association.

The section of this valuable series which has just come into our hands deals with "Science and Technology, including Hygiene and Sport." The section dealing with historical, political, and economic sciences appeared in November last year, and was reviewed in our January issue. Our former remark with regard to the indebtedness of the reading public to the work thus carried out by the *Athenæum* applies equally to the present Index. Wireless men who take their subject seriously will need no more than a notification that the volume in question is now available; they will find the present issue contains some references to a number of interesting papers which appeared in various British and American periodical publications during 1916.

THE STUDENTS' SERIES OF TEST CARDS (Series III.). A BOOK OF MODEL ANSWERS (Series III.). London: The Wireless Press, Limited. **1s. 6d. net each.**

It is now several years since Parts I. and II. of the valuable series of Questions and Answers first appeared on the market, and their ever-increasing popularity forms an eloquent testimonial of their value to the student. With the publication of Part II. of the *Elementary Principles of Wireless Telegraphy* a demand arose for further series of Questions and Answers, and in response thereto the Wireless Press, Ltd., has produced the set now before us. The same high standard of excellence has been maintained, and the student who conscientiously works through the questions will detect and remedy his weak points quite as surely as if he were verbally cross-examined by some expert teacher.

The book of Answers contains no less than 110 pages, and by virtue of its full treatment constitutes a complete text-book in itself, which may be profitably studied by all interested in the subject, whatever their degree of advancement. To the

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student preparing for the P.M.G. examination these cards and answers are absolutely indispensable.

In these days of strenuous endeavour, when all of us are attempting to fit ourselves for some work of immediate practical utility, such aids to self-training cannot be too highly valued or too largely multiplied. We doubt whether anything can ever hope completely to take the place of oral tuition, however intelligent the student and however excellent the teaching medium; but such a combination as the wireless books of Bangay, Parts I. and II., with the test cards designed to serve as their complement, immensely lighten the task of any teacher of radiotelegraphy, and in so doing increase the number of students with whom he can deal.

"THE PRACTICAL ENGINEER" ELECTRICAL POCKET BOOK AND DIARY, 1918. *London: The Technical Publishing Co., Ltd. Price* 1s. *and* 1s. 6d. *net (difference only in the binding).*

We have once again to welcome the appearance of this handy pocket book, now in its nineteenth year of issue. The 1918 edition contains all the old and valued features as well as several new sections, prominent among the latter being the new wiring rules of the Institution of Electrical Engineers and a selection of the new rules for electrical machinery of the British Engineering Standards Committee. Wireless telegraphy is well handled in Section xxxiii.

Several misprints of a rather irritating nature mar what is otherwise an excellent publication, and we look forward to seeing them corrected in a future edition. The following cases in point have come under our own notice. On page 49 we find the surprising statement, under "Ohm's Law," that $C = \frac{E}{I}$ where I = current, E difference of potential and R resistance · on page 84 there is an illustration of a "Witton" *Oil* Starter; and on page 329 a reference to *ten* discharge curves which obviously should be *four*.

After all, however, these are small blemishes, and easily remedied in subsequent issues. We have no hesitation in recommending the volume to all who require a handy pocket companion to help them in their electrical work.

SEA, LAND AND AIR, a new Australasian magazine. Published by the "Wireless Press" of Sydney, N.S.W. Price 9d.

The distinctive emblem adopted by our Australasian cousins consists of a kangaroo with the motto "Advance Australia." 'Tis a significant symbol with applications extending into many fields of activity. Amongst them is wireless, which, after many tribulations in early days,* is going ahead, kangaroo-like, "by leaps and bounds."

The latest antipodean radiotelegraphic enterprise consists of the production of a new magazine entitled *Sea, Land and Air*. The new-born journal sets before itself the task of dealing with the works and wonders of the Australian Navy and

* See our article entitled "The Progress of Wireless in Australasia," printed in THE WIRELESS WORLD for August, 1916.

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Mercantile Marine; the exploits ashore of the virile manhood and aspiring adolescents of the Commonwealth and New Zealand, as well as with the spirit of adventure which finds a fitting arena in the vast spaces of air. Wireless telegraphy, indispensable in all three media, forms the connecting link of the triad.

We have here a programme ambitious indeed, but one which the first number—just in our hands—gives good promise of fulfilling.

The "Sea" section of this new venture is adequately dealt with in a number of articles. We find one of "Centurion's" brilliant submarine-hunting sketches, an article by Mr. Archibald Hurd on "Intelligence in Naval Warfare," and a stirring narrative from an American wireless man of his adventures at sea. Mr. O. M. Bagot contributes an *exposé* of the "Maritime Peril" from Germany which Australia escaped through the advent of war, and which with the re-establishment of peace may once again threaten her unless her rulers and her people beware; whilst the issue reprints Mr. Alfred Noyes's dramatic sketch of submarine warfare at sea entitled "The Wireless Drama." This latter article, and the series of adventures of an American wireless operator, detailed under the title of "All in a Day's Work," by Clarence Cisin, constitute two of the most thrilling accounts extant of the "won-" derful experiences which have become almost commonplace amongst the officers " and men of the Mercantile Marine."

The "Land" side of the magazine finds itself represented by Mr. Hilaire Belloc's parallelism contrasting the "Russian and French Revolutions," by "Women's Work on the Land and Elsewhere," and by a graphically pictured account of campaigning from a correspondent in Palestine. An interesting item in this narrative of military happenings in the Holy Land consists of the account given concerning a captured German aeroplane pilot, who boasted to his captors of the wonderful surprise which the Germans had in store upon this front. There can be little doubt that General Allenby's campaign of attack "took the wind out of the sails" of an enemy offensive.

The "Air" part of the programme is carried out, so far as this number is concerned, by Mr. Fisk's illuminating article on "Steering Zeppelins by Wireless," a complete and noteworthy exposition of the methods adopted by enemy airships, and by twin articles on "My First Flight," by Lieut. Scarr, R.F.C., and "My Last Flight," by Lieut. A. W. Nowle, both special contributions to the new journal. Mr. Fisk's dissertation upon enemy airships' methods of finding their way is not only the work of an expert radiotelegraphist, but also of one who has enjoyed exceptional opportunities for investigating the subject upon which he writes. Amongst other cognate experiences, he enjoyed the unique privilege of listening to the wireless signals exchanged between a fleet of Zeppelins and their base, whilst the enemy craft were in the act of crossing the North Sea *en route* for one of their latest raids upon London.

A number of miscellaneous items like "Questions and Answers," "News and Notes," "Directions for Making a Flying Model Aeroplane," etc., round off a maiden issue of the highest promise. We congratulate our new contemporary and look forward with confidence to its appreciation by those for whose benefit it has been initiated.

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Personal Notes

Obituary.

We learn with regret of the death of Flight-Lieutenant C. H. Murray Chapman. Royal Naval Air Service, who was accidentally killed while flying on February 23rd, At the outbreak of war Mr. Chapman, who had a knowledge of wireless telegraphy, offered his services to the Royal Navy, and was appointed wireless operator on H.M.S. *Revenge*, taking part in the action off the Belgian coast in October, 1914. Later, he was minesweeping in the North Sea. In June, 1915, he obtained a commission in the R.N.A.S., and qualified for his certificate four weeks later.

We regret to announce the death in East Africa, from malaria fever, of Sergeant C. Atkinson, R.E., a wireless operator. Before the war he was on the telegraphic staff of the Midland Railway Company at Derby.

We also mourn the death at sea of Mr. F. R. Walker, a wireless operator in the service of the Navy.

The *Electrician* announces the sad news that Lance-Corporal S. Davies, R.E., senior partner of a Cardiff firm of builders and an instructor in wireless telegraphy in the R.E., has died of pneumonia.

Official notification has been received by Mr. and Mrs. J. W. Calton, of 75, Portland Street, Southport, to whom we tender our sympathy, that their son, Frederick John Calton, wireless telegraphist, was among the crew of one of H.M. ships which was lost in a storm off the coast of Scotland on January 12th. Mr. Calton was 19 years of age and joined the Navy in December, 1914, seeing considerable service on destroyers.

Promotions.

Captain G. Powell, assistant commandant of the wireless school at Farnborough, has been promoted to the rank of major. This officer was formerly employed at a post office in Wales.

Mr. W. G. Vickers, formerly superintendent of the messengers at the Fenchurch Street office, Marconi's Wireless Telegraph Company, Limited, has now received a commission. Lieut. Vickers was stationed at Dar-es-Salaam.

Awards.

We learn with pleasure from a Supplement of the *London Gazette* that W.T.O. 1st Class Walter F. Whitehead, R.N.R., has had conferred upon him by His Majesty the King of Italy a bronze medal for military valour.

Corporal Harold D. Tipler, wireless operator, R.F.C., has been awarded the Military Medal for bravery in the field on January 1st, 1918. We offer him our congratulations.

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On board H.M.S. *Eagle* at Liverpool, recently, Captain Sims presented the D.S.M. to the father of a boy telegraphist named Henshall for services in connection with a hostile submarine ; the lad was afterwards killed in another action.

Two Members of the Belgian Company's Staff.

We regret to have to record the death of two members of the staff of the Société Anonyme Internationale de Télégraphie sans Fil.

Acting Inspector Réné B. de Brucq, who died at Lisbon, of typhoid fever, was a native of Brussels. Transferred for duty with the Belgian Government wireless service shortly before the war began, he found himself at Antwerp during the German assault on that city. At the end of 1915 he resumed duty with the Société, and received an appointment as their acting inspector at Lisbon in 1917. During the revolutionary disturbances there he had the misfortune to be wounded by a bomb. M. de Brucq, who was 30 years of age, leaves a widow and son three years old.

M. R. B. DE BRUCQ.

Operator Alvara da Silva, who was 24 years of age, laid down his life in the execution of duty. The Portuguese steamer on which he served was lost by enemy action in December last ; and although we have no information regarding the timely arrival of assistance to the stricken ship, we know that the distress signals from her were received by both ship and shore stations in the vicinity. M. da Silva had for thirteen months been attached to the wireless service.

M. A. DA SILVA.

An Operator's Gallant Deed.

The crew of the Portuguese s.s. *Insulano*, which was wrecked last December at the mouth of the river Gironde, owe their lives to the perseverance, under great difficulty, of Telegraphist M. Carolina da Silva, who, although his cabin was badly smashed and repeatedly swamped by heavy seas, remained sending out the SOS signal until the last moment. Jumping into the sea, he was picked up by one of the ship's boats and eventually taken on board a French minesweeper. The *Insulano* became a total loss, but all hands were saved, a " happy ending " due to the gallantry of M. da Silva.

M. C. DA SILVA.

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Company Notes

The Amalgamated Wireless (Australasia), Ltd.

THE above Company held their ninth half-yearly meeting at Wireless House, Sydney, N.S.W., on February 28th last. Sir Thomas Hughes, M.L.C., Chairman of Directors, in moving the adoption of the Report and Balance Sheet, announced the payment of interim dividend at the rate of 5 per cent. per annum. He pointed out that the Reserve Fund had increased from £2,700 in June, 1917, to over £23,000. He held out little hope that revenue from public radiograms would show any improvement until after the conclusion of peace ; but the closing of this important source of revenue has been more than neutralised by the extension in the Company's manufacturing and general trading during the past twelve months. This expansion is expected to continue in view of further extensions made to the Company's factory and the installation of additional time-saving machinery.

The Chairman also announced the establishment of a branch of the " Wireless Press, Ltd." in Australia ; the main object being to conduct certain news services with the aid of wireless telegraphy, and to issue publications dealing with wireless and allied subjects. *The new organisation has already started operations by issuing a monthly magazine entitled " Sea, Land and Air," of which a review will be found on page* 187 *of the present issue.*

Sir Thomas Hughes paid a well-deserved compliment to the efforts of Mr. E. T. Fisk, the Managing Director, and to the gallantry displayed by a number of members of the Company's staff.

The meeting cordially endorsed the views of the Chairman, and passed the adoption of the Report and Balance Sheet. We print below the text of the above-mentioned Report.

DIRECTORS' REPORT.

PERIOD COVERED.—Your Directors have pleasure in submitting herewith the Balance Sheet and Profit and Loss Account for the six months ending December 31st, 1917.

NET PROFITS.—The net profits of the business during the half-year, added to the balance brought forward from last account, after providing for expenses of management, and adding the usual proportionate amounts to the Depreciation and Marine Insurance Reserve, and providing for all other expenses, amount to £4,074 os. 5d.

DIVIDEND.—Out of the above amount, which is available for distribution, your Directors recommend payment of an interim dividend at the rate of 5 per cent. per annum, absorbing £3,500, and carrying forward a balance of £574 os. 5d. to the next account.

BUSINESS OPERATIONS.—Your Directors regret to state that an important section of the Company's operations, public radio telegrams, from which in pre-war days a continuously growing revenue was derived, remains inoperative, owing to the very necessary restrictions imposed by the authorities responsible for the protection of all shipping. Acting in conjunction with those authorities, the Company has spared no effort to enforce the necessary restrictions, without considering the financial loss which it suffers therefrom.

Apart from the foregoing, your Directors are pleased to report that in every other

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direction the Company's operations are being successfully extended. Until recently your Directors have been able to report the progress of the ship operating department by giving the number of vessels using your service; but, as stated in our last report, we are advised not to publish those numbers during the war. Your Directors, however, are pleased to be able to record a further increase in the number, and anticipation of continued growth.

During the period under review your factory has been fully occupied with work of a highly important nature, and in view of the demand still being made for its products further extensions are being carried out. A large number of complete wireless telegraph stations have been manufactured during the past twelve months, and the factory is still particularly engaged in that class of work.

INVESTMENTS.—Your Directors have been able to invest a substantial sum in the Commonwealth War Loan without interfering with the Company's operations.

SHARE ISSUE.—During the half-year a number of the Company's shares were offered at auction by the Public Trustee, under the War Precautions Regulations. Your Directors, believing that it would be to the advantage of the Company that they should control the holding of such shares, acquired the whole of the shares on behalf of approved intending shareholders. At the time of the closing of the half-year's accounts the transfer of the shares to such purchasers by the Public Trustee had not been completed, but this has since been done, and the Company has been reimbursed all expenditure on this account.

DIRECTORATE.—During the half-year Mr. J. H. Forrest retired from the Board of Directors, and Sir Thomas Hughes became a Member of the Board by invitation. By the unanimous vote of the Directors Sir Thomas Hughes has also been elected Chairman of the Board. Captain T. Langley Webb, a Director of Huddart Parker, Ltd., has also joined the Board by invitation. In accordance with Article No. 83 these gentlemen retire, and due notice having been given they offer themselves for re-election at the General Meeting.

Wireless Congratulations

Senatore Marconi Radiotelegraphically Expresses the National Sentiment of Italy.

THE Fatherland of Marconi commemorated with great enthusiasm the anniversary of the entry into the war of the U.S.A. This occasion furnished an opportunity for expression of friendly feeling, which was eagerly seized by all the nationstaking part in this modern crusade.

A huge assemblage gathered at the world-famous Colosseum, where speeches were delivered by the United States Ambassador, by the Mayor of Rome, and by Signor Berenini. The King of Italy despatched a telegram directly from himself to President Wilson; whilst Senatore Marconi, over his own signature, transmitted a summary of the proceedings addressed to the U.S.A. President, most appropriately utilising wireless for the purpose. The terms of the message run as follows:—

> "The people of Rome have assembled to-day at the Colosseum to celebrate the "anniversary of the entry into the war of the United States. On this auspicious "occasion the signal honour is granted to me of being the intermediary for forwarding "this message, which is being transmitted through the free ways of space, expressing "to you the sentiments of sincere friendship and close solidarity which unite the "Italian people with those of the United States, together with our deepest admiration "for your initiative, which is inspired by the same principles which made Rome "great and which will maintain our faith in the triumph of right and civilisation."

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly.* (3) *Queries should be as clear and concise as possible.* (4) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers* (5) *The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

W. D. (Beeston).—(1) and (2) The distance that it is possible to transmit and receive with a Marconi 1½ kw. installation depends upon several factors. Within certain limits we may say that the larger the aerial the greater the distance that it is possible to transmit and receive, so that it is usual for a large ship to be able to send and receive over greater distances than a smaller vessel similarly equipped. Again the degree of sensitiveness of the receiver is an important factor, some of the modern amplifying sets enabling reception to take place over vastly increased distances. Generally speaking, on an average ship with the receivers usually installed, good readable signals are received in practically all conditions over a distance of 200 miles for a ½ kw. set, and 300 or more for a 1½ kw. set. In tropical and southern waters, greatly increased distances are frequently worked at night when conditions are "freakish." A number of cases have occurred where a ship with a 1½ kw. set has been able to communicate over a distance of 2,000 miles at night. (3) K.W. is an abbreviation of kilowatt. If you are not clear on the subject of power measurement in electricity you should study *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay. (4) It is not necessary to obtain a telephone headpiece in order to test your hearing, and in any case you would not be allowed to purchase any component parts of wireless apparatus at the present time. If you wish to practise telegraphy at home a key and loud buzzer is quite good enough for the purpose.

VALVES.—(1) No. (2) We cannot say definitely whether it will be possible to obtain all of the books mentioned, but if you wished to obtain them and were prepared to pay the price the Wireless Press, Ltd., would do their best for you. They could all be seen at the British Museum Library. (3) All British patents can be consulted free of charge at the Patents Office in London, or copies of any individual patents obtained at a small cost from the same place. If you have an opportunity of visiting the Patents Office Library, which is open daily without charge, you should certainly do so. You can then turn up any particular patent in which you are interested and see exactly what is claimed by the inventor.

SERGEANT J. D. (Belgian Army).—(1) Damping in this case is the dying down of amplitude in a train of waves and in a train of damped waves each successive wave is of smaller amplitude than the preceding one. In a train of continuous waves all are of the same amplitude. (2) Damped waves are usually produced by means of ordinary spark-discharge wireless apparatus and continuous waves by high frequency alternators, oscillation valves, arc transmitters or specially designed spark apparatus of the Marconi system. (3) Continuous waves can be received on ordinary damped wave receivers provided certain modifications are introduced. A description of these modifications cannot be given here through lack of space, but they are dealt with in Part II. of *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, price 2s. 6d., postage 3d.

A. B. (Carlisle).—The whole question of examination and prizes for scouts is suspended until after the war. At the present time no syllabus is issued for such examinations.

E. G. B. (Birmingham).—(1) This question must be settled by the Company's doctor. (2) An applicant for employment on the marine operating staff of the Marconi Company must pass that Company's doctor after his application has been received and before he can be finally accepted. It is essential that he should pass the Company's own medical representative, who alone is fully conversant with the requirements. This also answers Question 3. There is no reason why you should

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not visit your own doctor before taking the course and obtain from him an opinion as to whether you are physically fit in all respects. If you were not, of course it would be useless to proceed further with your course, but if you were you would still have to pass the Company's own doctor before acceptance.

IGNORANT (Durban).—There is no reason why the foil obtained from cigarette packets should not act equally as well as the tin foil, and we can only suggest that some of the connections are faulty or else that the condenser is too small for the purpose for which it was put. Why not try increasing its size? You state that the tabs are separate pieces, which raises in our mind a doubt as to whether you have made good electrical connection between the tabs and sheets. A further point concerns the speed at which the interruptions take place. In some very high speed mercury interrupters a condenser is practically useless, but if your break is of the ordinary low speed type this difficulty should not be found.

V. S. (Corscombe).—(1) The requirements of the service vary so much from time to time that we can only suggest that you apply to the nearest naval recruiting office for particulars. If you have obtained your P.M.G. Certificate at any Wireless Training College this would probably facilitate your entry, although as far as the R.N.V.R. is concerned youths are frequently accepted and trained by the authorities themselves. (2) The fact that a man is a wireless operator does not in itself qualify him for the rank of warrant officer. There are a number of wireless ratings in the Navy, the lowest being boy telegraphist. Some are "bluejackets," others petty officers, and still others warrant officers, while certain men engaged exclusively on wireless duties hold commissions from second lieutenant upwards.

SERGEANT A. B. (B.E.F.).—The wavelength of an aeroplane aerial is very roughly 3·25 times its length. This should enable you to arrive at the information you require.

R. B. L. (Scotland).—A youth attending a properly equipped and well conducted wireless school, and starting with no previous knowledge of the subject, should obtain his First Class Certificate in from six to nine months. It is impossible to state how long it would take to qualify by means of a combined correspondence and practical course. We have on several occasions in these columns asked readers to let us have their experiences with regard to the correspondence courses and the length of time taken by them to complete their studies, but so far no one has provided us with this information. We take this opportunity of repeating the query, as the information so gained would be very useful to our readers.

G. D. (Wexford).—(1) A telegraphist with a good knowledge of the needle instrument would be able to learn telegraphy as used in wireless much more rapidly than anyone with no knowledge whatever of telegraphy, but in the case of a student who is not already acquainted with the needle instrument we would not advise him to practise with it as a means of learning Morse for wireless. (2) No. (3) As we have stated on numerous occasions previously, we have no idea of what the requirements of the Marconi Company may be after cessation of hostilities, but it should be remembered that merchant ships fitted with wireless telegraphy during the war will without doubt retain their installations after the war. We cannot conceive that any shipowner once having experienced the uses of wireless would ever dismantle it from his ship. (4) On this matter we can only refer you to the school in question for particulars. A great deal depends upon your present knowledge of the subjects in which you would be examined.

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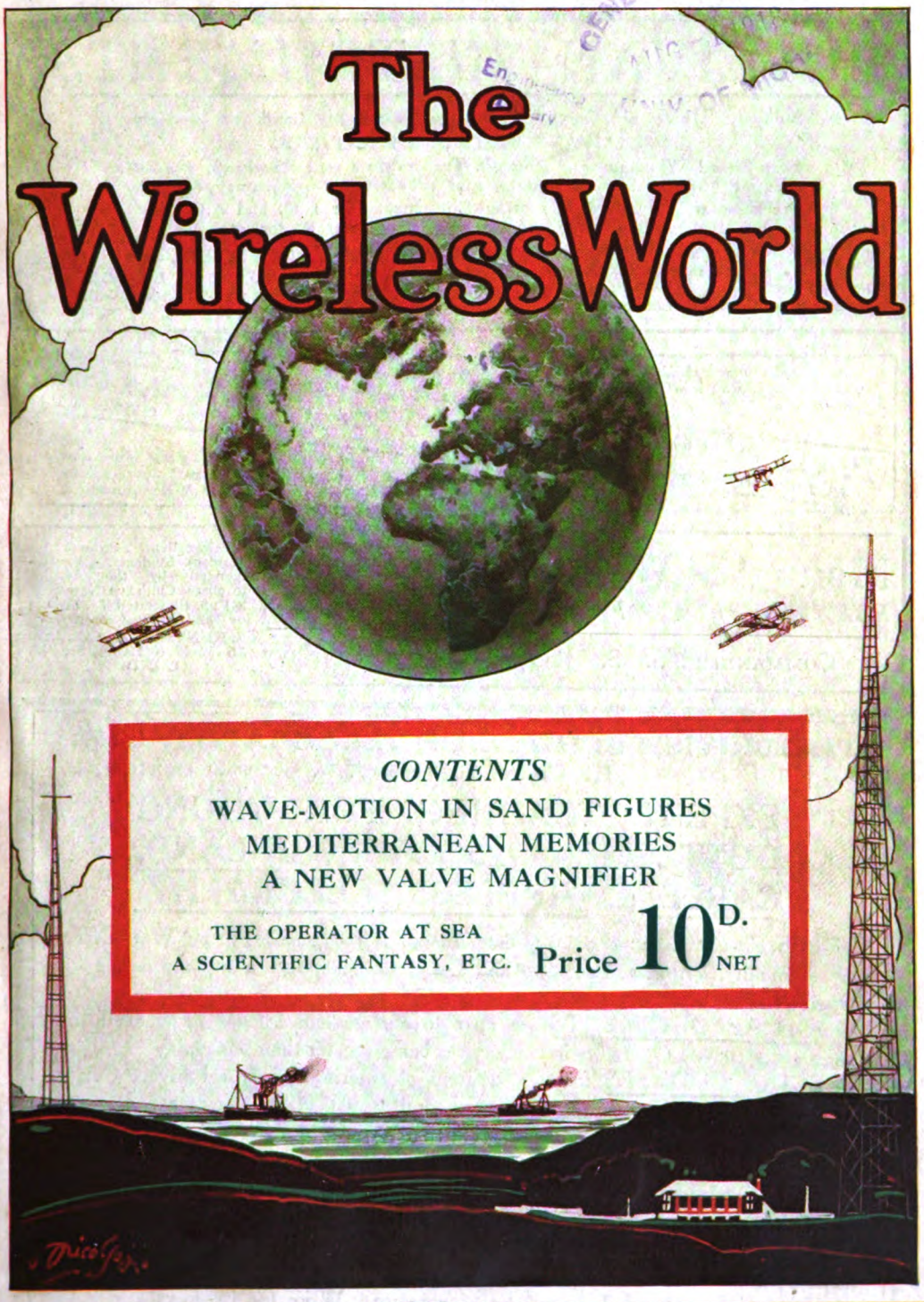
The Wireless World



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The
WIRELESS
·WORLD·

Volume VI. No. 64. JULY, 1918.

Winter in the Mediterranean

An Operator's Account of His First Cruise

By HAROLD WARD

OUR first appointment means much to all of us, and, in my own case, I was doubly justified in self-congratulation, for I received orders to join the R.M.S. *Celtic*, a famous White Star liner, on an occasion when she was chartered for a winter cruise in the Mediterranean by a prominent firm of American tourist agents. What more could a junior wish for? A short trip to "little old New York" just long enough to give me my sea legs, a fortnight there, and then away for a couple of months "rubber-necking," as our transatlantic cousins call it, in and about the most historic sea in the world. Assuredly nowhere else do we find such varieties of scenery, peoples and climates, packed within so small an area.

It all happened in the "piping days of peace," and the *Celtic* was not fitted with her present up-to-date gear. Despite a fair amount of "traffic," my senior had no complaints to deal with on our return, so that we must have "made good." The apparatus consisted of but a single ten-inch coil, with the result that we generally

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A VOLUMINOUS HEADGEAR FOR A WARM CLIMATE.

worked P.A. during transmission. We had no multiple tuner, but relied for reception upon an old "Maggy," a variable plug inductance-coil and a disc condenser. I need hardly say that in those days there was not half so much jambing as occurred later on, after the multiplication of stations, or I fear that our record would not have proved so blameless.

It is hardly worth while to dwell upon our journey to New York; over the first part thereof I am only too happy to be able to draw a veil—perhaps it is needless to say why! In due course, sailing day for the cruise proper arrived. Passengers and baggage came on board, first-class all of them, save for a few Italians seeking repatriation, and they arrived in such numbers that I wondered where they would all find room. The very ship seemed to palpitate with excitement; the "white feather" at the funnel top grew larger and larger until it finally burst forth in a thunderous roar, as though irritated at the delay. A bell rang out; visitors streamed ashore; the band struck up "The Star-spangled Banner"; and amidst a chorus of farewells and a cloud of waving handkerchiefs, we slowly slipped away from the dock, yielding with a dignified air to the fussy little tugs straining at their lines and sidling us out into mid-stream. Slowly we "came about," the engine-room gongs clanged, and away we went down the Hudson, till all the waving hands and little flags first blurred into an indistinct mass, and finally vanished altogether. Even to-day I always feel on leaving a port the same peculiar thrill as then went through me. As matters stood then, I had to go on watch immediately, and missed the wonderful sight of the crowded shipping huddled in the lower reaches.

A few pleasant days at sea brought us within sight of the lovely green hills of São Miguel, the most important member of the Azores Archipelago. Never did hills look greener or houses whiter than on the day when we dropped anchor off Ponta Delgada, the capital city of the group. The island of St. Michael, as it is more commonly called by English-speaking people, though situated some thousand miles from the Iberian Peninsula, is officially reckoned a constituent part of Portugal, and not merely a colonial town as would be the case under the British *régime*.

SHEEP-DRAWN CART IN THE STREETS OF ST. MICHAEL'S.

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It possesses a perfect climate, and fruit in endless variety flourish in the open, whilst we see on every hand such strangers to our temperate zone as plantations of tea, coffee and sugar. Many curious sights greet the eye as one strolls around the quaint little streets; that which most impressed me being the tiny carts drawn by sheep. So far as my own experience goes, this is the only place in the world where such animals are used in this way, and the illustration reproduced on the opposite page will give some idea of what it looks like. Heavy carts, with solid wooden wheels and wicker sides, lumber along and creak over the cobbles as the driver noisily urges his oxen onward. Strange, too, appear the peculiar head-dresses worn by the women; their vastness of spread and sombre black tint would seem as though they must prove oppressive to their wearers in such a warm climate. Once again we have —as indicated in our picture—an illustration of the popular proverb "Pride feels no pain." The general effect produced upon my mentality by life in this favoured land was a sense of peace and perfect content; and indeed the feeling which I experienced

THE BUSY WHARVES AND DOCKS OF THE OLD "PIRATE CITY."

appears shared by both island and people. Small wonder that the ancients should have included this amongst their "Islands of the Blest."

Here, as in all Roman Catholic countries, churches abound, and the pleasant-toned bells are ever calling the faithful to prayer.

I quitted the Azores with regret, and, although up to the present I have not been afforded a chance of returning, I registered a vow that I would take the earliest opportunity of so doing, "when my ship comes home."

Gibraltar was our next port of call, and I felt to the full all the fascination of the "Rock" (as it is familiarly called). The scenes here have, however, been so frequently described that it is needless for me to dwell upon them, save for a passing remark on the cosmopolitan nature of the crowd which throngs the lower streets.

After this, our way lay through glistening seas to Algiers, the ancient home of piracy and slave trading, familiar to us all from the adventurous yarns we enjoyed as boys. Although piracy of the forcible variety has passed away, a modernised form still exists, and corsair-touts carry on piratical attempts upon the purses of tourists all through the frequented ports of the Mediterranean. Their outward

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A CONFAB OF CRONIES ON THE GRANDE PLACE, ALGIERS.

appearance is varied; but guides, itinerant musicians, and pedlars of worthless faked curios, continue to maintain the ancient tradition of preying upon "the Stranger within their Gates."

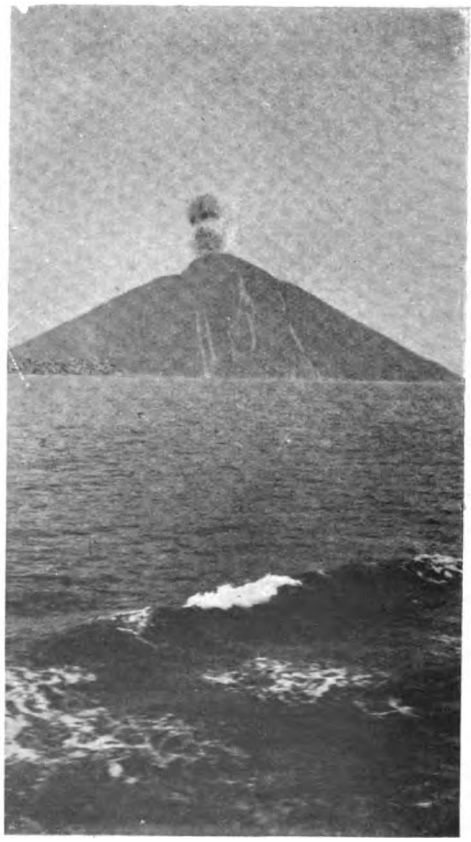
The ship's mate has a favourite yarn about the tout's idea of fun, and it is in Algiers that the scene was set. I will retail it here for the benefit of those who do not happen to have heard it before; 'tis a standard tale which varies but little, except that it is usually narrated as having happened to the teller:

I could not get rid of him. He offered me postcards, cigarettes, curios, etc.—especially etc.—to all of which offers I returned a firm "NO!" As a last resource, to lose no opportunity of doing business, he whined "Ah, sare, you come along o' me to-night, I show you *plentee* fun. Last night two men killed; to-night plentee more fun."

Climatic conditions are so favourable that many Europeans winter here, and a number of fine modern hotels have sprung up which, although somewhat incongruous amidst the surrounding streets of dirty native haunts, add immensely to the comfort of those who desire to make a prolonged stay. It was here that I first realised the full meaning of the Biblical phrase "the Street that was called Strait."

Many of the purer Arabs are rather handsome; that is to say, so far as the menfolk are concerned. With regard to the women, it is impossible to express an opinion, their faces being so enveloped in drapery that two gleaming dark eyes are usually all that one can see as they shuffle past you. The central *Grande Place* of Algiers—a handsome, spacious, open space paved with stone—presents a kaleidoscopic scene of ever-varying humanity in Eastern and Western garb alike. Our illustration depicts an Eastern group holding a confab at one corner thereof.

Hence we pass on to Alexandria, stopping only for a short interval at



STROMBOLI, BELCHING SMOKE AND STREAMS OF LAVA, WITH HUMAN DWELLINGS NESTLING ALONGSIDE.

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Malta. I was amused at the way in which the people on this island evade the danger of watered or adulterated milk. *The milkman brings his dairy with him!* What I mean is that he drives a flock of goats from street to street and taps them on the doorstep of his customer.

As soon as we arrived at Alexandria our decks quickly became converted into an Oriental bazaar. Streams of Arab traders clambered over the rails and displayed their wares to the fullest advantage. What an assortment of goods and rubbish they offered for sale! Scarabs, carpets and cheap jewellery were commingled with heaps of tins of cigarettes, until one had scarcely room to move. The vendors price their articles according to what they think the intending customer will give, but are easily beaten down to half (or even less) of their original demand by an astute old-timer. Practically all the jewellery and metal curios are of Brummagen origin in reality, although highly coloured stories of their value and rarity fall glibly from the lips of the traders. The native quarters ashore are well worth a visit. Here the trading is mostly done on stalls such as those shown in the picture on page 200; whilst bargaining, even for trifles, is carried out on the same chaffering lines. My shipmates and I made the usual excursion to Pompey's Pillar (which has nothing to do with the Great Pompey at all), and near by we saw some interesting catacombs, believed to be the tombs of Early Christians. Should it fall to your lot, reader, ever to visit them, the guide will probably show you, as he showed us, a chamber which has only been opened that day. It is likely indeed that your party (like ours) will be the first to enter it! Be discreet, as we were, and refrain from asking your informant how so many European names came to be scratched upon the walls!

A GLIMPSE OF THE SEA-SIDE WALL AT MALTA.

After the heat of Alexandria I was not sorry to meet the fresh breeze once more, and welcomed the sea voyage which lasted till we passed through the Straits of Messina and arrived at Naples.

The Straits of Messina present some magnificent pictures: the comparatively narrow waterway runs between high snow-capped mountains towering on either side, and the verdant slopes of these giant hills are dotted here and there with little clusters of white-painted houses.

Stromboli lies to the north of the Straits and presents a sight worth seeing by day or night. The volcano is constantly active and, during the day, high clouds of smoke come volleying out of the top, followed by the dull rumbles of some internal explosion, whilst molten lava can be seen running red hot down the mountain side until it pours hissing into the sea, wherefrom rise huge clouds of steam. It is said that, when Stromboli stops, Vesuvius starts. However this may be, smoke may nearly always be seen hovering over the crests of both. At night the dull glare of Stromboli

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is almost constant enough to serve as a lighthouse, and several of our passengers lost their beauty sleep staying up to enjoy the spectacle.

An old English proverb says " A burnt child dreads the fire," but apparently the proverb does not hold good in Italian, for, in spite of many catastrophes, the dwellers by the sides of active volcanoes still persist in building their houses along their sides. Possibly the soil is more fertile on the slopès, but most of us would imagine that a smaller crop reaped in safety would be preferable to a slightly larger one matured in such dangerous proximity. Our illustration shows Stromboli under these conditions and indicates the temerity with which the buildings cluster close to the current of the molten stream.

" 'Twere long to tell " the tale of all the ports we visited and all the sights we saw. What I have already narrated must suffice as a sample. Our voyage was divided into a number of cruises, each of a little over a month, and one and all afforded a round of pleasure and enjoyment from start to finish. Even the time at sea was spent in sport, cricket and deck games being the order of the day ; concerts, dancing and cards rounding off the enjoyment by night. We wireless men found ourselves not overworked, as all the passengers were " on pleasure bent," so that, except for a few service messages and the listening-in during our watch time, our radiotelegraphic duties were light. Altogether I have extremely pleasant memories of my first wireless voyage at sea.

EGYPTIAN FRUITSELLER'S STALL, " SNAPPED " IN THE NATIVE QUARTER OF THE CITY.

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The "Wireless Press" Armature Model

A New and Ingenious Aid to the Study of the 1½ kw. Converter

FEW pieces of apparatus in the standard 1½ kilowatt Marconi ship installation invite such careful study as the rotary converter. Superficially, its action would appear to be simple, seeing that it may be considered as an ordinary D.C. motor, from the armature of which alternating current is tapped off and led to slip rings. But directly we come to study its function in detail a number of problems arise, none too easy of solution.

Until now the student who has not had access to a dismounted armature has been severely handicapped by reason of his ignorance of the exact method in which the windings are arranged. Seeing that the armature is cylindrical, diagrams can give very little help, for they must necessarily be flat. The ideal way to pursue the study would, of course, be to place oneself before a complete armature and trace the circuits on the actual machine. This, however, is obviously impossible.

In the circumstances it is a great pleasure for us to announce that the "Wireless Press" have now placed on the market a remarkable ingenious model of a 1½ kw. converter armature on which every slot and every winding is clearly shown. The model, which is issued in the flat, consists of three parts, one requiring to be bent into a cylinder, and the remaining two fastened to its ends. Built up, the model —some six inches in diameter by eight in length—carries on one end the commutator figures, and on the other the slip rings. Starting from any particular segment of the commutator the windings can readily be traced from start to finish, thus making clear to the student not only the principle of lap winding, but also many other important matters in dynamo construction.

As the number of slots, the number of conductors and the general arrangement of windings have been faithfully copied from the standard converter, the student enjoys the same facilities for study as he would if he were the possessor of the armature itself; and further, as adjacent conductors are shown in different coloured inks, there is no risk of confusing two windings in the same slot, which may happen on the actual machine. The uses to which such a model may be put are too numerous to mention here, but will occur at once to every student.

Full instructions as to making up are issued with every model, together with a brief description of the converter windings, and nothing more than reasonable care is required for its construction. For rough handling and class use the model can be reinforced with wood or cardboard in one of many ways which will occur to any ingenious student or instructor. Best of all methods would be to turn a wood cylinder to the exact size of the model. On such matters the Editor will always be pleased to hear from readers so that their individual experiences may be published for the benefit of all.

Operators, students, instructors and all interested in practical wireless work, as well as students of motors and dynamos generally, will be well advised to secure this model at an early date. The price, it may be mentioned, is 1s. (or 1s. 3d. post free), a sum which brings their admirable aid within the reach of all. The first edition is already on sale, and—as a large demand is anticipated—orders should be placed at once to avoid delay or disappointment.

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PERSONALITIES IN THE WIRELESS WORLD

SIR RICHARD GLAZEBROOK

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THE National Physical Laboratory, founded in 1899 for standardising, testing, and research work, fully justified its existence from the start; and its importance was, even during peace time, recognised in a dozen directions. Since the initiation of the present struggle, its peacetime achievements have been vastly exceeded by its wartime activities. The full extent of the services rendered by this admirable institution can only be revealed in the happier days to come, when the present censorship is withdrawn; but we may state that in radiotelegraphy alone—to mention but one of its many paths of research—the work conducted under the able supervision of Sir Richard Glazebrook has proved of the greatest assistance to the Allied cause.

Sir Richard Tetley Glazebrook, Kt., the distinguished Director of the Laboratory, whose portrait figures on the opposite page, was born in 1854, and educated first at Liverpool College and afterwards at Trinity College, Cambridge. His exceptional gifts soon manifested themselves; for we find that in 1876 he won the high position in the mathematical tripos of Fifth Wrangler, being elected Fellow of his College in the course of the following year. Five years later he became one of the University Lecturers. In 1866 he was Hopkins Prizeman at the Cambridge Philosophical Society, whilst in 1909 he received the Hughes Medal of the Royal Society. Amongst the positions he has held, we may enumerate those of University Lecturer in Mathematics, Assistant Director of the Cavendish Laboratory, and Principal of University College, Liverpool. The last-named post he vacated to take over the Directorship of the National Physical Laboratory on its first initiation in 1899, entering upon the duties of his post on January 1st, 1900. In 1906 he was elected President of the Institution of Electrical Engineers.

Knighted by the King in the course of last year, Sir Richard is a Companion of the Bath, a Master of Arts and a Doctor of Science. His publications include a number of treatises on Physics, Mechanics and Electricity, whilst he has fulfilled, in a manner that has won the general approbation of all concerned, the onerous task of editing the valuable series of the Cambridge Natural Science Manuals.

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Mechanical Analogies to Inductively Coupled Electric Circuits

By H. M. BROWNING

I.

Introduction.

If a condenser is charged up and then discharged through an inductance, damped simple harmonic electric vibrations are set up, with frequency of the order a million per second. It is easy enough to imagine the nature of so simple a discharge, and the motion of a simple highly damped pendulum is analogous to it. But if two circuits containing inductance and capacity are placed so that they act and react on one another, two superposed simple harmonic vibrations are set up in each circuit, with frequencies which differ from each other and from the free vibrations of the separate systems. But obvious as theory may make this to the trained mathematician, it is difficult to bring it home to the average electrical student. Hence any mechanical analogies that can be visibly coupled, adjusted and worked, are helpful to students trying to grasp the subtle electrical phenomena which make no appeal to the senses of sight and touch.

Two types of pendulum have been used to illustrate the electrical phenomena. These can be set up from materials at hand in any laboratory and very fair results obtained. With more costly apparatus any student can make experiments with speed and accuracy.

As it is difficult to follow the intricacies of the motions while they are being executed, the pendulum bobs should carry funnels to give sand traces on moving boards.

Two electric circuits are said to be coupled when they are placed so that they act and react on one another. The closer the coupling the greater is the mutual induction between the circuits. The looser the coupling, the smaller the mutual induction. If two pendulums are made to act and react on one another they may be described as coupled, and their coupling may be increased or diminished.

Loose coupling in an electric circuit is about 3 per cent., medium coupling 10 per cent., and close coupling 47 per cent. With the pendulums, couplings from 0 to 60 per cent. have been obtained.

It has been found that for the double-cord pendulum with bobs of equal mass and lengths equal, the ratio of the superposed vibrations formed by coupling them is identical with that for the electrical case having the same couplings.

In the present paper the two types of pendulum are described with some of the results which have been obtained with them. In a later paper it is hoped to deal shortly with the mathematics involved and show how theoretical results have coincided with and been fulfilled by experiment.

The Cord and Lath Pendulum.

The model here called the cord and lath pendulum consists essentially of two pendulums, PR and QS, one suspended by cords from a movable point, R, on the lath of the other, as shown in Fig. 1. The bobs are shown by P and Q, the movable and fixed points of the suspensions by R and S. The cord pendulum is shown by PR. When the apparatus is used for giving double sand traces, a system of four cords and three stretchers is used so as to clear the upper board which takes the trace of the bob, Q. Each cord is provided with a tightener for adjusting its length. The point

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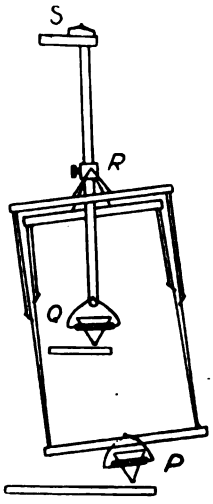

FIG. 1. CORD AND LATH PENDULUM.

of suspension, R, is adjustable on the lath of the pendulum, QS, by a small sliding metal sleeve, with studs to adjust the cords. This sleeve is set where required and then fixed by a screw-clamp. The suspension, S, of the lath pendulum consists of two screw points resting in a hole and slot in a metal plate. The two bobs, P and Q, are metal rings, with glass funnels for sand. The boards shown just beneath the funnels are fixed on the same wooden carriage and are capable of simultaneous slow motions on horizontal rails perpendicular to the plane of the diagram. This motion is effected by the rotation of a wheel whose axle winds a cord attached to the carriage. The whole arrangement is shown in the photographic reproduction, Fig. 2.

In the work carried out with this pendulum, the lengths of the suspensions were equal, and also the masses of the bobs. If the length SR is small, the pendulum is said to be loosely coupled; in this case the ratio of superposed frequencies of vibrations is only slightly different from that of the separate pendulums. But as SR is increased, the coupling also is increased until, when SR is about two-thirds of SQ, the coupling is 48 per cent. and the frequency ratio 2 : 1. It is difficult with this arrangement to get really loose coupling, as for 15 per cent. (*i.e.*, medium) coupling the lower bob is just clear of the upper board. Fig. 3 presents four sets of traces obtained with various couplings. Of these (1) to (3) show single traces from the lower bob when the upper bob was struck; the couplings vary from 15 to 45 per cent. In the fourth trace (4) the coupling was about 48 per cent., and a trace was obtained from the upper bob simultaneously with that from the lower bob. The two boards were placed side by side to be photographed together.

On examining photograph (1) of Fig. 3 it is seen that the bob has no amplitude at A, and in three vibrations it has reached a maximum, and then, after the same number has again fallen to zero at B. The vibrations occurring within the distance AB may be called a beat cycle. The greater the number of variations to a beat cycle the more nearly alike are the two superposed vibrations of the pendulum. Thus in the first the ratio of the frequencies is about 5 : 6.

Photograph (4) of Fig. 3 shows in the upper curve what appears to be almost simple harmonic motion, but with successive amplitudes, alternately long and short. The lower curve has vibrations of

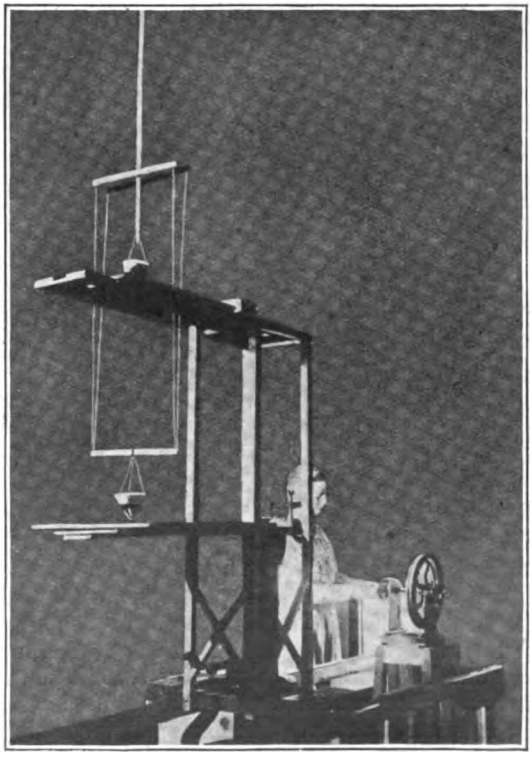

FIG. 2. CORD AND LATH PENDULUM.

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frequency half that of the one above, but with a wandering kink. Both these are due to superposed vibrations, of which the frequency ratio is 2 : 1. In the top curve the amplitude of that with the greater frequency is predominant, and in the bottom one that with the less frequency.

This pendulum is very good for quickly demonstrating how change of coupling affects the ratio of the frequencies of the superposed vibrations. Yet, while it is fairly simple to arrange a rising movable stand so that sand traces from the lower bob may be obtained, it is more difficult to get a stand which can receive curves from the upper and lower bobs simultaneously.

THE DOUBLE CORD PENDULUM.

This pendulum was first rigged up with extremely simple apparatus and most

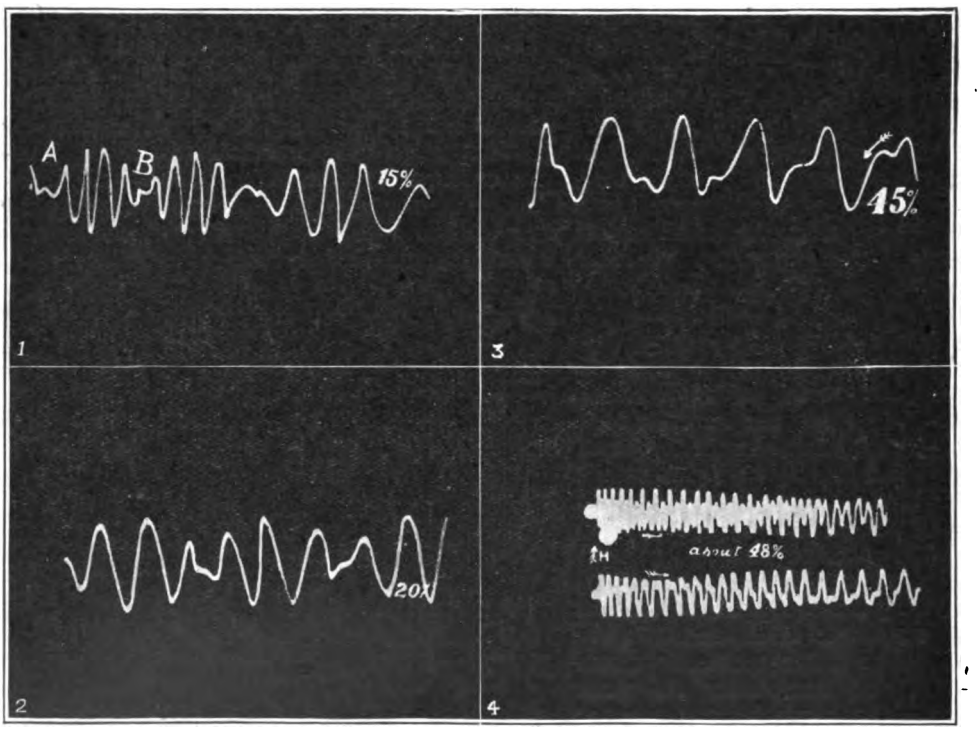

FIG. 3. TRACES FROM CORD AND LATH PENDULUM.

of the work was done with this. Later it was desired to make a portable apparatus with certain refinements for quicker and more accurate work. Figs. 4 and 5 show the original design in elevation. In the normal use of the pendulum the oscillations occur in the plane of Fig. 5. In this figure is shown a stiff connector, CC^1, which forces the bridles, ACA and $A^1C^1A^1$, to swing together. The bridles were attached at A to beams in the roof.

One bob consisted of a heavy metal ring holding a glass funnel, the other bob was either the same as the first or simply a cardboard funnel with weights to make it the required fraction of the mass of the heavy bob. Each contained sand to give the vibration trace on the blackboard. This was mounted on wheels and was slowly pulled along the floor below the bobs. The length of each pendulum could be

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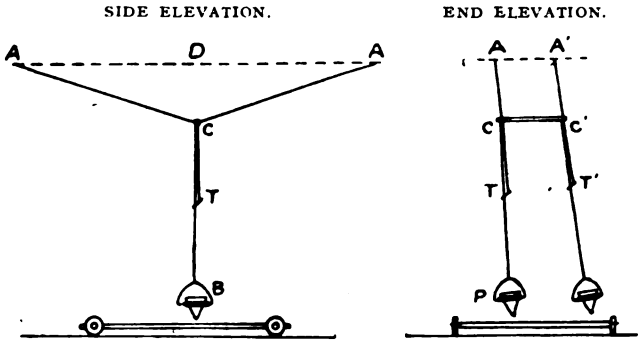

FIGS. 4 AND 5. DOUBLE CORD PENDULUM.

adjusted by a sliding tightener (T, T^1) and the bridles set to any desired droop by adjustments at their end A or A^1.

When ACA was nearly straight the coupling was very small, but as the droop ACA was increased the coupling increased. For pendulums with equal bobs and equal lengths 1, the droop was β 1 and the coupling was equal to $\frac{\beta}{2+\beta}$. Also theory shows that for any one coupling the ratio of the frequencies of the superposed vibrations is identical with the ratio for the electrical case, in which the circuits have the same frequencies when separate.

THE PORTABLE APPARATUS.

This apparatus is shown in Fig. 6. It consists essentially of a braced framework of deal, 1½ inches square, the main rods being each 6 feet long. The bridles are of whipcord and are fastened off on cleats or blind-cord fasteners. The suspensions in actual use are of wires of different lengths, with hooks at each end, the fine adjustment being altered by a thin cord and tightener (as for tent ropes). In order to get a clear photograph the bridles and suspensions were replaced by coarse white cords. The two longitudinal rods at the base of the apparatus are provided with rails made of hoop iron set into saw gates along their length. These rails carry four ball-bearing door sheaves which are fixed on the under side of the board arranged to receive the sand traces. To draw this board along, a cord passes from the centre of one end through two tension eyes to a bobbin on the frame. Attached to the bobbin is a long arm which can be rotated by hand as slowly or as quickly as desired. A little practice enables the operator to turn regularly and at the rate best suited to the traces in view.

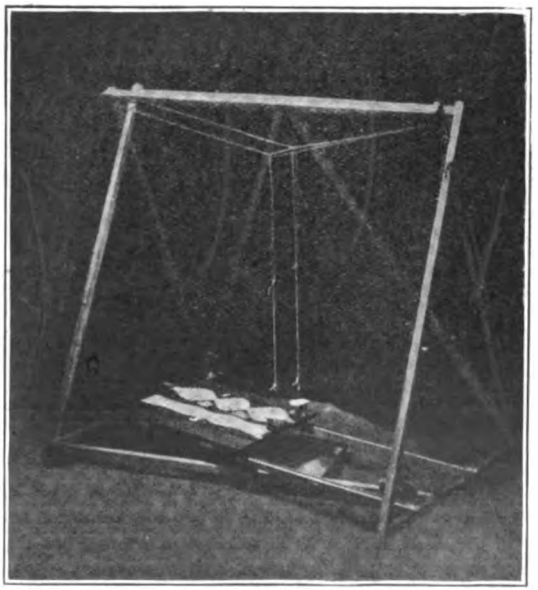

FIG. 6. DOUBLE CORD PENDULUM.

In the early experiments with this pendulum the vibrations were started by giving one of the bobs a blow. Later one bob was held aside, the other, for small couplings, being allowed to rest in its more or less displaced position, or for large couplings held undisplaced; both bobs were then freed simultaneously.

When the masses of the bobs are equal the method of starting has very little effect on the nature of the vibration for couplings up to

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40 per cent., but for greater couplings the one bob held undisplaced and the other drawn horizontally aside gives the most striking result, as may be seen from the last photograph of Fig. 7. The photographs indicate by signs or figures how the motions were started.

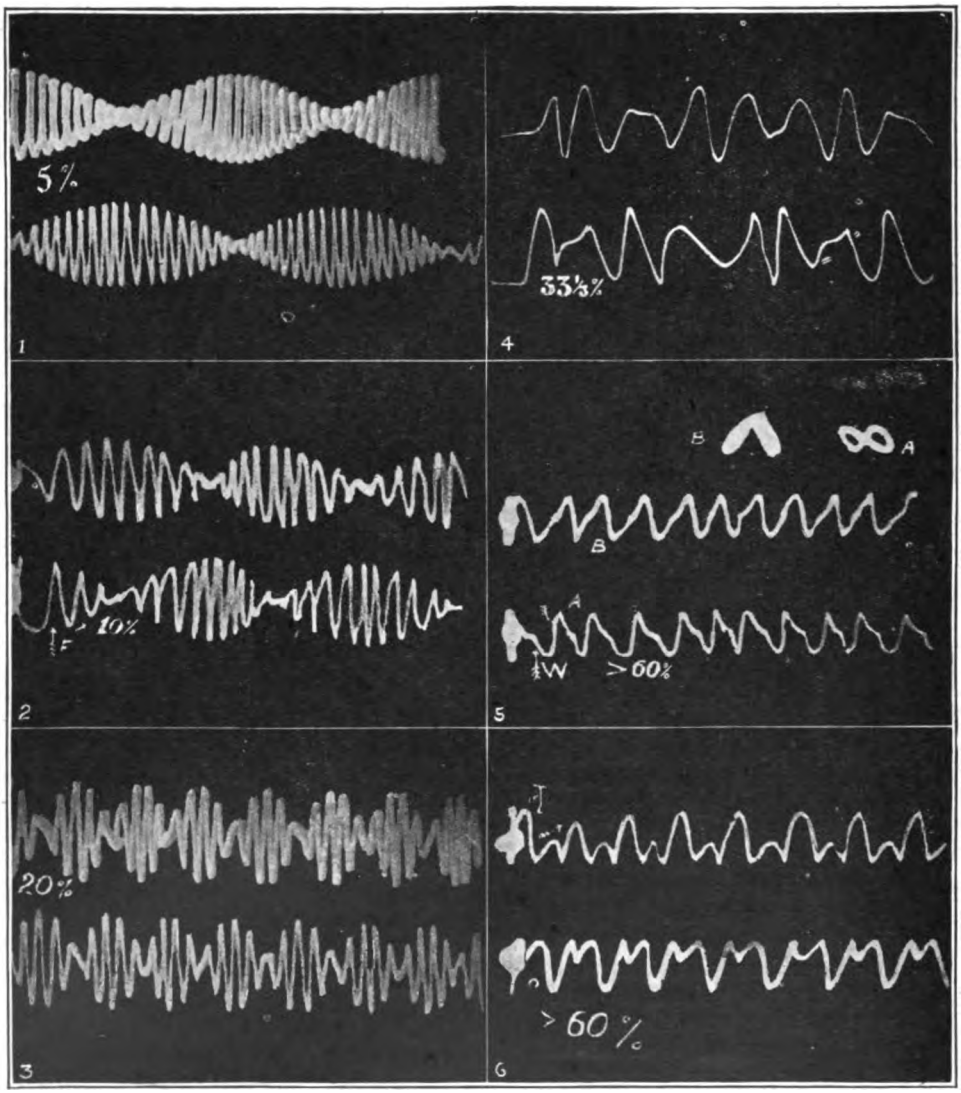

FIG. 7. TRACES FROM DOUBLE CORD PENDULUM.

Photographs (1) to (4), Fig. 7, show the gradual change from loose to tight coupling. The couplings are indicated on each photograph as percentages. Traces (1) to (3) show loose and moderate coupling and exhibit the phenomena of beats and the slow surging of energy to and fro between the bobs. The vibrations appear to be simple harmonic throughout, but of slowly changing amplitude. This is the natural consequence of the superposition of vibrations of only slightly different periods. Also it is striking how one bob gives up the whole of its energy and the

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other just attains the amplitude with which the first one starts, and then in its turn transfers its energy to the first bob. These cases are like coupled electrical circuits with equal inductances and periods.

For tight coupling, over 30 per cent., it is noticeable that the beats have disappeared and are replaced by simple vibrations with a kink in each one or in every other one. This is because the frequency ratio is nearly 2 : 1. In photographs (5) and (6), Fig. 7, the frequency is exactly 2 : 1. For traces *A* and *B* on photograph (5) the board was also turned through a right angle and left stationary while the pendulums were used as Blackburn's pendulums. They thus gave simultaneously the patterns in the top right-hand corner, which were retraced almost perfectly about ten times.

The Quenched Spark.

Fig. 52, p. 714, of Prof. J. A. Fleming's *Principles of Electrical Wave Telegraphy and Telephony*, Second Edition, shows "the electric beats produced in the primary "and secondary circuits when a sustained primary spark is used and the single periodic "oscillations in the secondary circuit when the quenched spark is employed." The mechanical analogue of beats was obtained and is described above. Photograph (1), Fig. 7, shows it. The damping was not so marked as in Prof. Fleming's case because our damping factor was almost negligible.

To produce the effect of the quenched spark the masses of the bobs were equal and also their separate frequencies, the coupling being 10 per cent. One of the bobs was drawn aside and the other allowed to hang in its slightly displaced position. The bob was then freed and its oscillations were quickly diminished by the transference of its energy to the other pendulum, which in about six vibrations had attained an amplitude equal to that with which the other pendulum started. The first pendulum had at this instant lost all amplitude, and it was then suddenly raised by the hand and held in this position, while the other bob oscillated with a single period. Fig. 8 is a photographic reproduction of the sand trace thus obtained. The lower trace represents the quenched spark and the upper the vibrations set up in the secondary or antenna.

In a later paper it is hoped to deal briefly with the theory and show how experiment fulfils it; also to show traces taken with the double-cord pendulum when the bobs differ in mass and the suspensions in length.

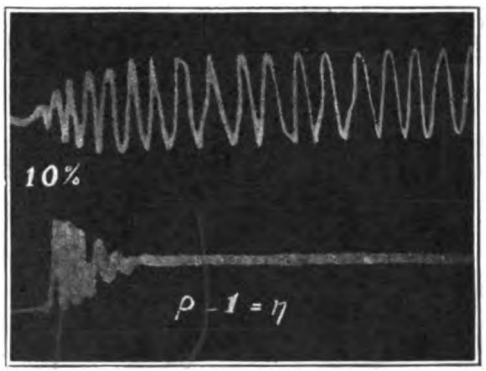

FIG. 8. QUENCHED SPARK.

Correction

Professor Paul Baillie advises us that the nomogram, Fig. 4 (page 44), in his article printed in our April issue, contains an error. The gradations of the "frequency n" scale are not in accordance with those of the λ scale. Instead of 10^7 (in front of 300m) 10^6 should be read, and everywhere instead of 10^6, 10^5 should be read. Those of our readers who use this scale will probably have noticed the error and corrected it accordingly.

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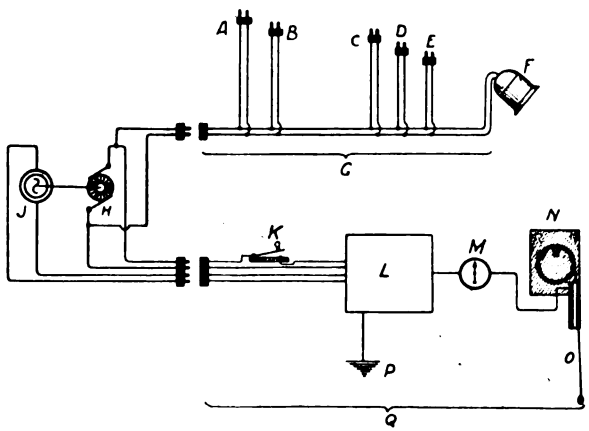
Digest of Wireless Literature

German Wireless Apparatus on Aeroplanes.

Writing in a recent issue of *La Nature* on the evolution of German Aviation, Lieutenant Jean-Abel Lefranc states that for some little time the enemy machines have been occasionally equipped with continuous wave receivers of the valve type. Describing the transmitting apparatus, he says that the generator produces alternating current (270 volts 3 amps.) and continuous current (50 volts 4 amps.). The machine is driven either by a small airscrew rotating at 4,500 revolutions per minute, or by the motor. The alternating current produced by this generator is utilised by the "oscillating circuit" which gives rise to the oscillations creating the Hertzian waves. The Telefunken "sender" consists of a rectangular box containing a transformer, a condenser, a plate discharger and a wavemeter. Special arrangements permit of variation of wavelength and intensity of transmission.

The aerial consists of a copper wire approximately 35 to 40 metres in length. On the ground this wire is rolled up on a bobbin. During flight it is suspended from the machine.



The range of these sets is about 30 km. and their weight in all 26 kg. The latest giant aeroplanes guide themselves at night by radiogoniometers, as the Zeppelins do.

It will be noticed from the diagram reproduced herewith that the generator supplies current for several purposes. Thus the leads A go to the electric warming apparatus in the pilot's clothes; B to the lamps on the instrument board; C to the observer's clothes; D and E to heating apparatus on the camera and machine gun respectively. F is the searchlight for night landings. All G is therefore concerned with lighting and heating. H and J are the D.C. and A.C. sides of the generator, while K is obviously the transmitting key. L contains the Telefunken transmitters; M and N and O are the aerial ammeter, the aerial bobbin and the antenna itself. All Q is the purely "wireless" apparatus.

Future Radiotelephone Legislation.

Writing in the *Wireless Age*, Dr. Alfred N. Goldsmith says:—

"There is one direction in which radio legislation properly conceived can

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" greatly assist the radiophone field. This is by providing a system whereby every " ship and its corresponding shore station have available not one or two but a " considerable number of wavelengths. These wavelengths, which should be " designated by letters or numbers for the sake of brevity, would all be available " for communication except those that were in actual use *near the receiving station.* " That is, the receiving station, after listening for a moment, would dictate to the " transmitting station the suitable wavelength for communication without inter- " ference. Naturally all calling would be done on a common wavelength which " might be, for example, the present-day 600-metre wave. This system of a multi- " plicity of legal wavelengths and the choice of one of them for communication in " accordance with traffic conditions at the receiving station has great possibilities " and should be carefully considered for future action.

" One further interesting possibility of radiotelephony on board ship may be " mentioned. A simple phonograph recording and reproducing device run by a " small motor might be provided so that, in case the passengers and crews are " forced to desert the ship after a serious accident, the phonograph can continue " to repeat into the radiophone transmitter the necessary call for help, the name " of the ship, its location, the type of accident, and the action taken by the passengers " and crew. This would, to some degree at least, relieve the operator from the heroic " but frequently fatal stand which up to the present he has always taken. With " this simple device installed, he has at least the same chance of rescue as the other " officers of the ship."

METHOD OF GENERATING HIGH FREQUENCY CURRENTS.

The Compagnie Générale Radiotelegraphique describes in French Patent 444,356, and Supplementary Patent 16,369, methods for generating high frequency currents. According to the methods described it is possible to prevent arcing at the spark gap by means of a condenser connected in series with the gap.

In the usual methods an alternator is connected through inductances to the spark gap that forms at the same time part of an oscillating circuit containing inductance and capacity, and arcing is prevented by resonant charging of the feeding circuit, by cooling the electrodes of the spark itself, by the use of spark gaps in which the length of the gap is altered synchronously with the supply frequency, or by the use of generators supplying alternating voltages of peaky wave shapes.

In the methods now described a second condenser is connected between the spark gap and one of the supply mains. This arrangement enables supply voltages to be used of any frequency without the necessity of adjustment for each frequency. The arrangement may also be used in association with the anti-arcing devices already referred to. It is calculated that to obtain a maximum of energy the capacity of the condenser in the branch containing the gap should be slightly greater than that of the condenser in the capacity inductance branch connected across the mains in parallel with the branch containing the gap and the anti-arcing condenser. For shock excitation at high voltages rotating gaps should be used, and by provision of teeth and synchronous rotation of the gap it is possible to obtain a spark discharge every 1, 2, 3 or 4 half-periods. If, on the other hand, the gap is driven non-synchronously irregular sparking is produced that gives rise to characteristic tones by which the sending station may be easily recognised. In the supplementary patent similar arrangements are shown in which commutated direct current is used instead of alternating current.—(*Jahrbuch der Drahtlosen Telegraphie und Telephonie*, August, 1917.)

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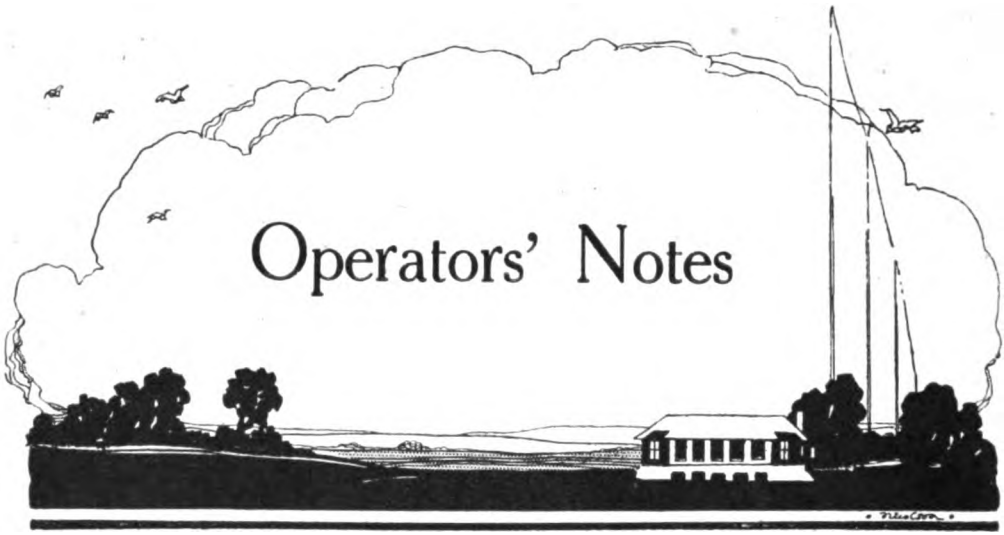

The Operator at Sea (II.)

By F. B. RUSHWORTH

NOT only is the operator making his first trip, at sea literally and metaphorically, but he is introduced to many new conditions, amongst them being a language strange to his ears. This language is often referred to as "nautical terms," but perhaps a more correct way of putting it would be "land terms" translated into nautical language. Most sea-going men are familiar with the landsman who, speaking of a ship, referred to her bow as the "sharp end" and her stern as the "blunt end," wondering meanwhile at the grin on the sailor's face. Ignorant of sea language, he described what he saw in the only way he could express himself. To gain some familiarity with common sea parlance and customs, then, on putting to sea is an advantage.

Time at sea is divided into "watches," during which the crew, equally divided into the "port" and "starboard" watches, go alternately on or off duty. Each watch (with two exceptions) lasts four hours, so throughout the day and night the men work or rest alternately for that period, but in order to prevent their always having exactly the same hours, the watch from 4 to 8 p.m. is divided into two, called the first and second "dog watches," and as these "dog watches" last only two hours, the men then get time for a little social recreation. There are seven watches in the course of twenty-four hours, called respectively the first, the middle, the morning, the forenoon, the afternoon, and the first and second dog watches. The first watch is from 8 p.m. till midnight. Not the striking of a clock, but the striking of a bell, marks the flight of time on board ship. One bell is struck at the end of the first half-hour in each watch, two bells for the next half-hour, and so on increasing a bell each half-hour, till the striking of eight bells indicates the end of the four hours' watch. Of course, only four bells are struck at the end of each "dog watch."

To be on "watch on deck" is to be on duty, and when off duty, on "watch below."

The captain, or, properly speaking, the master, is, of course, supreme in all and over all aboard ship. Some commanders may object to smoking on deck. It is always improper and against discipline to smoke on the gangway when entering

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or leaving a ship, and a punishable offence to smoke on dock premises. If allowed to smoke on deck, never do so near open hatches. See that cigarette or cigar ends are properly extinguished and carried to an ash tray, not thrown on the deck or overboard. Fires are easily started, but terribly hard to extinguish. All spoiled official forms must be torn up and then burnt. The chef will generally allow this to be done in the galley fire.

"C.O." is a short term for chief officer, whose slang title is the "Mate." He is practically the staff captain, and is responsible to the captain for the whole of the deck department. The word "mate," prefixed in the order of rank, is commonly given to officers above the rank of fifth officer, whose slang term is "Fiver," or, amongst his familiars, "Dog's Body." The second mate is the navigating officer. In addition to keeping their watches, the third mate is responsible for the correct receipt and delivery of the number of mail bags, etc., from and to the Post Office authorities, and the fourth mate is in official charge of the passengers' baggage. The boatswain (pronounced bo'sun), a very important petty officer, is in charge of the sailors and deck-hands, and the bo'sun's mate is his assistant.

A steamship does not possess a "chimney"; the smokestack, or funnel, carries away the smoke from the fires.

What the kitchen is on shore the galley is on board ship. A "head wind" is against the ship and a "soldier's wind" is a following wind. The "Fiddley" is the part of uppermost deck where the smokestack and ventilators emerge, and the "hold" is the lowermost compartment of the ship. A "hatch" is an opening to a deck below, also the planks used to cover it, and a "booby-hatch," a temporary structure leading to the deck below. The hatches are numbered consecutively forward to aft. The intermediate decks, upper, middle and lower, are known as "'tween decks." There are no walls, floors or ceilings within a ship, but "bulkheads" and decks. Bilge means the waterways in the bottom of a ship and bilge tanks are compartments for storing water, salt or fresh. "Chips" is the slang name for the carpenter, who performs the vital duty of sounding the tanks and recording the depth of water they contain.

One does not "go to bed" or "get up," but "turns in" and "turns out." To go from one deck to another is not spoken of as going up or downstairs, but up or down the companion. A ship is not so many feet broad, but has a beam of so many feet. Forward (pronounced for'rad) is the fore end of the ship and aft is the aftermost part. A sailor does not climb the mast, but "goes aloft," and by the "ratlines," not ladders. The rope ladder by which a pilot often boards a ship is called a "Jacob's Ladder." A log, besides being an official record, is also the name given to a mechanical device for recording distance travelled by a ship. The port side is on the left-hand looking forward and the starboard on the right hand. The weather side is the windy side, and the lee, the sheltered side—and incidentally anything allowed to be thrown overboard must be thrown over on this side. If put over the weather side it will be either blown back on deck or through some port hole that may happen to be open. To go to leeward (pronounced loo'ard) means away from the wind.

The forecastle (pronounced fo'c'sle) is the forward end of the ship, and in it are situated the living quarters of the crew.

Messages on ship's business for transmission and delivery will mostly be conveyed between the bridge and wireless room by quartermasters.

These are men who have been promoted from A.B. (able-bodied seaman) and come under the immediate supervision of the fourth officer. Two are on watch at the same time, one taking a "trick at the wheel"—*i.e.*, steering—or at the helm, and the other standing by the officer on watch on the bridge. The shining brass and spotless condition of the bridge generally and the hoisting and dipping of the flags and ensign are their care. When the ship is at anchor, or tied up alongside in port, they relieve one another standing by at the gangway.

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Wireless Telegraphy In the War

THE PROGRESS OF AERIAL WIRELESS.

WE make no apologies for our constant reference to the ever-increasing influence exercised by aircraft in warfare. The poets and writers of old days showed the true spirit of inductive reasoning in likening the atmosphere, which floats around the surface of the globe, to the sea, and in speaking of the "Ocean of Air." It is largely on account of this similarity that Wireless assumes the same all-important rôle in the one case as it has over a considerable period done in the other. It was impossible for the development of aircraft to attain its present position till means had been found of utilising radiotelegraphic means of communication for the thousand and one purposes which it fulfils under modern conditions. Until a pilot could regularly communicate and receive communications in mid-flight he was in the position of the old-time navigators at sea. The moment he had climbed into the aerial regions and disappeared from sight he became a lost unit, up to the time when he once more emerged and landed. Without radiotelegraphy, aerial tactics, to say nothing of strategy, would have been impossible.

Accounts of the present critical clash of arms upon the Western Front are filled full of references to aerial efficiency. At Fère-en-Tardenois an artillery column was put out of action by aircraft fire as it advanced towards the Allied lines. On another occasion the officer in command of an air squadron launched some fifty machines against an enemy column that was occupying over three miles of road. The onslaught of the aeroplanes was like a cavalry charge; it consisted of a swoop made at an elevation of but ten or twenty yards above the level of the ground, and resulted in the pouring upon the enemy column of a hail of machine-gun fire which only ceased after the Boche had been completely dispersed. One of our contemporaries, the *Motor*, recently went so far as to discuss the possibility of landing a force behind the enemy's lines through the instrumentality of a large fleet of aeroplanes, pointing out that there are already machines capable of transporting twenty-two men each. It is obvious that if 1,000 such machines, operating as a military unit, could land troops equipped with machine guns behind the enemy's lines, such a method of attack would prove even more dangerous than an outflanking movement. The control of squadrons of planes like those envisaged in movements of this character must be conducted on similar lines to those of fleets at sea, in which radiotelegraphy habitually plays a vastly preponderating rôle.

As was recently pointed out by the well-known expert, Captain H. B. C. Pollard, at the time when our present struggle commenced the aeroplane's wireless apparatus was a very elementary thing, but little more, in point of fact, than a laboratory

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toy, although useful in its way. At that stage the pilots were not trained signallers, and—as a rule—those fliers who made it their business to "spot" for the guns were accompanied by an artillery officer who acted as an observer. The latter assumed the responsibility for signalling to the battery with which the aeroplane was working.

Photo] [Newspaper Illustrations.

IN THE "OCEAN OF AIR."

To-day all pilots and observers alike are trained in wireless work. It forms part of their professional qualifications, and the radio equipment of a modern aeroplane makes a wonderful advance upon the primitive outfit formerly used. The perfecting of aircraft wireless goes hand in hand with the rapid forward development of the craft themselves. Radiotelephony, when it comes into more extended active practical employment, will—like many other improvements concerning which silence must at present be maintained—still further increase the potentialities of the Air Service.

TRAINING AND ORGANISATION.

A visit to the class rooms which form an important part of aerodrome organisation would show you a number of embryo airmen seated along benches fitted with small practice sets of Morse keys, buzzers and flash signalling lamps. There they practise sending messages until a certain standard of efficiency is reached, after which they move on to the second stage in their Pilgrim's Progress. This stage centres round the inspector's table, where the instructional apparatus is much more complicated and the tutorial arrangements include the recording of pupil's messages by an automatic tape machine, which relentlessly discloses every slip and error which occurs in the sender's work.

We find the third scene in this drama of systematic training set amidst scenery which reproduces something like the actual conditions of an aeroplane in flight. The men are clothed in their flying garb and have to work their keys with gloved fingers as in the air, whilst instruments, specially designed for that purpose, reproduce the complex noises of a machine in flight. The final touches to the "Complete Airman" are naturally "laid on" in actual machines. Pupils who have passed the preliminary tests set out on long continuous flights with instructions to keep themselves in wireless contact with the operator at the aerodrome throughout their period in the air.

AMERICANS ALSO.

The above sketch, for the main features of which we are indebted to Captain Pollard, refers more particularly to British conditions. Our American cousins are following on similar lines. The illustration which we reproduce on page 216 shows a lady instructor, Miss Elise Owen, in the act of administering radiotelegraphic tuition to a number of selected men belonging to Class A, the scene being laid at the Murray Hill Evening School, New York City. Not until the pupils, whom we

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see at work, have attained a minimum speed of ten words a minute, are they inducted into Brother Jonathan's service and transferred to a Radio Camp for the completion of their training. After completing their course, the young Americans are afforded opportunities of securing commissions in the Signal Corps, and this branch of the service over there (as on our own side) proves specially attractive to young men of an enterprising type. Incidentally, it may be remarked, our picture illustrates the way in which American corporate bodies of all kinds are throwing themselves into the prosecution of this crusade against the Hun. The class depicted was instituted by the New York Board of Education with the object of helping such men effectively to prepare for their army careers.

WIRELESS FOR COASTAL DEFENCE.

The exploit of the *Vindictive* and her consorts on St. George's Day, naturally and rightly, completely captured public imagination, and has been dealt with so fully elsewhere that but little remains for us but to add our quota to the chorus of admiration so justly earned on that occasion by our glorious Navy. There is one point, however, which was referred to by Colonel Repington in his critique upon this naval feat which deserves some passing comment from ourselves. Writing on the difficulties which had to be overcome, the well-known critic says :—

> " Sound-ranging, and the easy discovery of the position of any ship by " intersection on wireless stations of the assailant's resorts to wireless, add " fresh dangers to an approach to the coast, and the enemy may well have " regarded his defence as impregnable."

For a gallant officer who would appear to claim that " his pen is mightier than his sword " the above passage is not remarkable for its clarity of expression. What we presume he meant is that the enemy has organised a system whereby—employing direction-finding receivers at coastal wireless stations—he can easily discover the

Photo] [*Topical.*

AMERICAN AVIATION PUPILS RECEIVING WIRELESS INSTRUCTION FROM A LADY TEACHER.

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position of approaching vessels through the instrumentality of the wireless messages which the latter must perforce radiate at intervals if acting in concert. Of course the moment that the position of an approaching vessel is localised by *any* means whatsoever, that vessel is immediately liable to be overwhelmed by accurate gunfire. Such an organisation as the Colonel refers to is perfectly feasible, and would fully justify his inclusion thereof amongst the most formidable obstacles with which our naval units were obliged to wrestle on that memorable day. Against such a radio-telegraphic defence our smoke screen would lose a large part of its value. Smoke does not interfere with wireless waves. Nothing but the most superb handling on the part of the British naval commanders could possibly have countered this scientific means of protection.

As a matter of fact, the more we investigate in detail our Navy's wonderful feat of organisation and seamanship, the more unbounded becomes our admiration for every one who planned or took part in it.

German Submarine Wireless

THE report of the War Cabinet for 1917 contains some information concerning recent developments in "U" boats, the later type of which possesses a surface speed up to 18 knots and a submerged speed from 10–11 knots. Our contemporary *The Army and Navy Gazette*, in commenting on the items contained in the report quotes the statement of an American writer that by means of small balloons a submarine can raise her wireless to the height of 1,000 feet or more. According to the same authority the receiving range of these underwater craft may, in favourable conditions, be estimated at 3,000–4,000 miles; so that, by a system of "relaying" from one submarine to another, the distances which can be covered in the way of message-transmission might total up to a very considerable figure.

A Novel Application of the Valve

The New Marconi Double Note Magnifier

FRESH applications of the three-electrode valve are ever-increasing in number, and this month we are able to present our readers with a couple of diagrams which illustrate a case in point. These figures, which will be found on pages 224 and 225, depict the new Marconi Double Note Magnifier, as applied to the magnetic detector and the crystal receiver respectively. Briefly, the instruments consist of two three-electrode valves connected in series with one another in such a way that the telephone currents from the magnetic detector or crystal receiver are magnified in two successive stages before being led to the telephones themselves. The valves thus act not as detectors but as amplifiers. All circuits have been simplified to the highest degree so as to remove the need for adjustments. Electrically there is no difference between the model for the magnetic and that for the crystal except in the design of the first transformer, the primary for which has, of course, to be of lower resistance for the magnetic detector than for the crystal. In one model a switch takes the place of three sets of terminals, and is connected in such a way that, when working direct without magnification, the valve filament circuits are broken. When using first magnification, *one* valve only is in circuit, whilst for second magnification *both* valves are in circuit. Otherwise the arrangements are the same.

The total magnification obtained with this new instrument is such that signals from the magnetic detector are at least three times as strong as those obtainable with a crystal receiver. It will be noticed that a 200-volt battery is used for the plate circuit.

By the addition of the note-magnifier to the magnetic, we have available a receiver which possesses the notable reliability of the magnetic, and far greater sensitiveness than the crystal, which—with the exception of the more complicated forms of valve receivers—has hitherto formed the most sensitive commercial type.

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"Clean Bowled!"

A Scientific Fantasy

BY WILLIAM D. OWEN

THE sound of music and laughter that floated in through the open porthole singularly annoyed me. It was wretched luck that this particular night of all nights should have been chosen for the fancy-dress ball just when I needed absolute quietness for the success of my experiments. Last night's Press bulletin at 1,850 miles was certainly an achievement, but if I could copy it to-night at 2,215 I could undoubtedly claim the record for this route.

Of course, the portholes might be closed, but then it is no joke working in a hermetically sealed cabin with the thermometer standing at 90° to begin with. However, I was keen to prove the merits of my "Show us a lite" detector, even at the risk of suffocation, so grumbling I screwed up the ports, divested myself of as many of my garments as I could with decency, and settled down to work.

Eagerly I moved sliders across inductances, varied the capacity of tuning condensers and adjusted the coupling between the different circuits of my receiver, straining my ears all the while for Poldhu's familiar note, but not a sound of it rewarded my efforts. Again and again did I go over the connections, test the insulation of the aerial and switch in various specimens of the precious crystal so carefully mounted beforehand, but all without avail. For the fourth time I pulled out my watch and compared it with Greenwich mean time, as indicated by the cabin clock, thinking that something might be wrong with my allowance for difference in longitude, and still no clue.

Disappointed in my hopes and exhausted by my frantic efforts, I laid my head on my arm and made a mental survey of all the factors bearing on the subject. How long I lay thus I know not; but suddenly I became aware that I was not alone; in fact, someone was speaking to me.

I looked up sharply at the intruder, annoyed that he should have entered without knocking. He was a youngish looking man, tall and thin. His features were sharp and rather melancholy. The straggling black hair upon his face had plainly never felt the caress of a razor, and his frock coat and black Alpine hat gave him the appearance of a Mormon elder or an undertaker's mute.

"I hope you will pardon this intrusion," he was saying, "but really I could not contain myself any longer. Everybody seems to have gone mad. They are all dressed up in absurd costumes and are pirouetting around the deck yelling like a lot of Apaches. I understood one of them to say that they were 'lancers' or something of the sort, and one charming lunatic actually asked me to 'make a set,' whatever that might mean. So I ventured in here because this is the only sane spot on the ship."

"Why not try the engine room?" I said, sullenly.

"Engine room!" he spluttered. "I never see a steam-engine without burning with shame and indignation. Of all the insane products of a mad age the reciprocating steam-engine is the worst."

He was so earnest, so emphatic, and his eyes glowed with such unnatural zeal that this talk of madness merely recoiled upon himself, in my estimation.

"The chief engineer would be interested in your remarks," I suggested.

"The Chief is at this moment disguised as a sergeant of the marines," he replied, with irony, "and if his accomplishments in engineering are at all comparable with his skill in mimicry he will already know that his beloved engines and their accessories waste nine times as much energy as they usefully employ."

"You don't say so!" I said, aghast.

"I certainly do," was his reply. "In fact, I go further and say that the energy

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continually wasted up the funnel of this ship alone is sufficient to run a fleet of sixty such vessels if utilised strictly in accordance with modern scientific discoveries."

To say that I was amazed at this assertion is to express myself feebly. Of course, it could not be true, I thought, and I'm afraid I must have shown my doubts, for he launched out into a long dissertation upon the efficiency of fires, boilers, steampipes and engines. He proved, at least to his own satisfaction, that only 10 per cent. of the heat energy of coal is converted into useful energy at the crankshaft, and to my feeble protests he merely replied, "You can verify this by referring to any standard treatise on the subject. Even the Chief will not deny it."

"Well, what of it?" I flared up at last. "If these things worry you why don't you get busy and show us how to improve matters? Our engines and our ships have literally brought the uttermost ends of the earth together. While some folks spend their time in destructive criticism others get busy with the crude tools at their disposal and get the world's work done."

"Young man," he said, gravely, "your shafts fall wide of the mark. I have discovered a storehouse of energy so vast and so revolutionary in its effects as to reduce the value of our best engines to that of scrap iron."

"My dear sir," I said, with excessive politeness, "I am not even impressed by your assertion. That storehouse of energy has been repeatedly discovered at seemly intervals ever since I was a child in short frocks. Once it was called 'liquid air' and later it was called 'radium.' I don't know what you are going to call it, but I venture to guess that it won't get much farther than the pages of the sensational section of the lay press, where so many of these wild-cat schemes lie in their graves."

"Your remark, if you will forgive my saying so, is an ignorant one. It suggests that you get your scientific information from the lay press. What, for example, do you know of radium?"

"Oh, the usual," I said, recklessly. "One teaspoonful will propel the *Mauretania* across the Atlantic in nine seconds. An ounce will yield enough energy to send a twenty-car Pullman backwards and forwards from here to the moon for ever. That sort of thing went down all very well when I was a gawky schoolboy, but I've got beyond that nonsense now."

LIKE A MORMON ELDER OR AN UNDERTAKER'S MUTE.

"And do you know why your boyish anticipations were not realised?" he asked.

"Yes," I answered. "Simply because, in my ignorance, I anticipated the impossible."

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"Oh, no! not at all!" was his retort. "The pent-up energy within one teaspoonful of radium, as you so scornfully put it, is sufficient to do what you say, allowing, of course, for your obvious exaggeration; but the difficulty in the past has been *to release that energy fast enough*. The disintegration of the radium atom takes place so slowly that thousands of years must elapse before the process is complete, yet even at that rate it yields an appreciable amount of energy *all the while*. Power, as you should know, is the rate of doing work. It is evident, then, that the power developed by a piece of radium is very small—almost negligible. Stimulate the process of disintegration so as to allow the inter-atomic energy to be released at a greater rate and you have power enough to do all the absurd things you spoke of, in so far as they are practicable."

"Well, Professor," I said, jocularly, "what are you going to do about it?"

"It is ten years since I first asked myself that question, and now I have answered it to my satisfaction. I can disintegrate the radium atom by blowing it to bits with X-rays, and, what is more, I can control to a nicety the power developed by regulating the intensity of the X-rays with Coolidge's apparatus."

I was really impressed by this time, for my little stock of scientific knowledge enabled me to appreciate the validity of his principles even if I could not agree with his methods. At the same time I saw many obstacles and, after smoking in silence for awhile, I returned to the debate. "Even if you can substantiate your claim, sir," I went on, a little more respectfully this time, "you must admit that the amount of radium available is distinctly limited and that its price is prohibitive."

"Quite so," he said, smiling a confident smile, "but *all substances down to the commonest have this inter-atomic energy*. Radium happens to be one that yields energy to an appreciable extent without suasion. Radium is not stable, it is slowly disintegrating all the while, and it gave us the clue to this vast source of power. My researches prove conclusively that the disintegration of *any* substance involves the release of inter-atomic energy in quantities that make the thermal energy of coal and petroleum like a drop in the ocean in comparison, and I can disintegrate any substance, stable or otherwise, by my application of the X-rays."

THE "PONCEPHALUS" OR "BRIDGE OF BRAINS."

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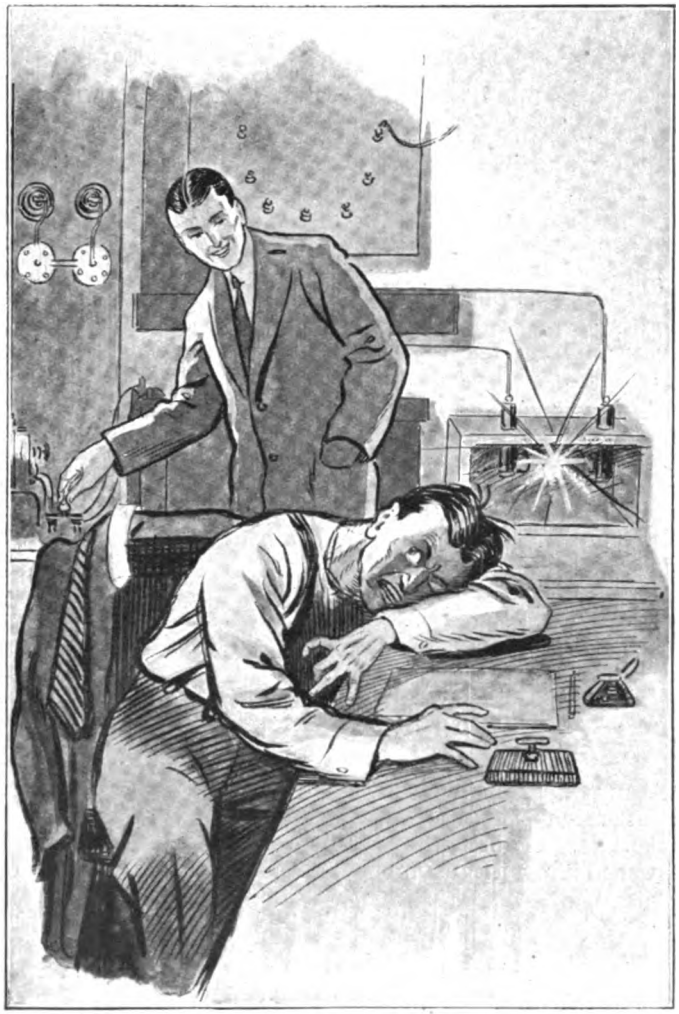
I was too excited now even to think of apologising for my previous rudeness. Undoubtedly he had made an amazing discovery, probably the greatest since Newton discovered the laws of gravitation.

"In what form is this energy released?" I asked; "and how do you propose to handle it?"

"Well, it is obvious, is it not, that when the electron complexes which form the atom are broken up and the positive component absorbed into the earth we shall have a very powerful stream of electrons moving from the disintegrating body at a great velocity. This electron stream is, as you know, an electric current, but before it is used as such it is deprived of its purely mechanical energy by allowing it to impinge upon the blades of a specially designed turbine, the rotor of which is in vacuum and attains the enormous speed of a hundred thousand revolutions a minute. Centrifugal force is counteracted by magnetic attraction between the shaft and the blades of the rotor.



A RUDE AWAKENING.

"By Jove!" I said, with genuine admiration, "you seem to have considered everything. Permit me to compliment you upon your wonderful foresight and, if I might say so, your abnormal mentality. Do you conceive these ideas as a result of inspiration or as the outcome of a laborious mental process?"

"Mental force, of which the brain is the centre, is just as potent a thing as mechanical force or electrical force," he assured me, "and it follows precisely the same laws. In mechanics we learn that a number of forces acting in the same direction merge together to form one force equal in magnitude to the sum of the individual forces. Then, again, in electricity we obtain a large electromotive force by connecting generators in series. So in Super-psychology—the study of mental problems beyond the normal—I obtain an abnormal concentration of mental force

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simply *by connecting brains in series.* A number of assistants are thrown into an hypnotic trance, and in obedience to the suggestion that they are research workers engaged upon epoch-making discoveries they set to work with a vigour and concentration that is seldom attained in normal circumstances. I then couple them all up in series by means of an original device I have called the 'Poncephalus,' or bridge of brains, and loop myself into the group. My mind is then the objective mind of the circuit; it directs and stimulates the subjective minds. Thus, you see, I can get any degree of mental concentration by increasing the number of assistants, and can therefore solve any problem that is capable of solution."

In the circumstances it was natural that my mind should associate his last remark with my own particular problem—that of increasing the range of my receiver—and I made the most of the golden opportunity that presented itself.

"Perhaps you will be good enough to assist me in my endeavour to read Poldhu at a greater distance than has ever before been done on this route," I suggested; "already I am beginning to fear that I have lost him."

"That should not be a difficult matter," he said, musingly. "The strength of your signals depends upon two things—the amplitude of the waves that strike the aerial, and the sensitiveness of your detecting devices. You probably approach the problem from the latter standpoint, but I would prefer to look to the amplitude of the incoming waves. In fact, I am already engaged upon a similar problem in connection with my Automatic Thought-Recorder, which is destined to abolish the laborious process of writing down, letter by letter, thoughts that come and go like motes in a sunbeam. The greatest difficulty I had to overcome was the minuteness of the emanations from the thinking brain. A careful study of telepathy and thought-reading convinced me that these emanations were actual ætheric pulses, but the amplitude was too small to operate the recorder I had invented. I therefore devised the 'Amplitude-augmenter.' Fortunately I have one with me." So saying, he took from his pocket a little white-wood box and abstracted therefrom a small glass bulb with several protruding electrodes. Deftly disconnecting the aerial he inserted the device in the breach and, wonderful to relate, weak signals began to come in almost immediately, and as I listened they grew louder and louder. But what nonsense was this they spelt out? I grabbed my pencil and wrote:

> "How doth the busy little bee delight to bark and bite.
> He gathers honey all the day, and eats it up at night."

As my pencil skimmed over the paper, recording these mystic sentences, the intensity of the signals grew ever louder until it became impossible to keep the telephones on the ears. Grabbing frantically at them I tore them off as the volume of those signals swelled into a great symphony of sound, terminating in a crash—and I was awake!

* * * * * *

Gentle reader, I blush to confess it—I had fallen asleep on my watch, and, sad to relate, my junior had discovered me thus. Calling to mind the sound wigging I had given him for a similar offence, he paid me out by opening up the discharger box, which was close to my recumbent head, and tapping out that doggerel verse with full power on.

Dimly realising that I was the "busy little bee" given to barking and biting, and that the rhyme constituted a cleverly concealed taunt, I grabbed up a paper-weight with intent to hurl it at his head, but before I could carry out the intention I beheld his retreating back framed in the doorway and heard the echo of his parting shot:

"How's that, Umpire? CLEAN BOWLED!"

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Notes of the Month

Official Recognition.

We observe amongst the list of honours recently published that Mr. W. W. Bradfield has been made Commander of the British Empire. We congratulate the genial Manager and Director of Marconi's Wireless Telegraph Company on his appointment, which constitutes not merely an acknowledgment of national indebtedness to him as an individual, but also as a representative of an institution which has, ever since the war started, been executing invaluable work in the interests of the nation.

His colleagues seized the occasion for demonstrating the high personal regard which Mr. Bradfield inspires in all who come into contact with him. A lunch at the Savoy on June 13th formed the occasion. Mr. Godfrey Isaacs took the chair, and representatives of the various branches of Marconi activities vied with each other in paying their tribute. The Chairman struck the note of fraternity and informality, which was well sustained throughout the gathering. The usual toasts were honoured and the usual speeches delivered.

A Tribute from the Foe.

The British daily press were able recently to publish the German General von Hutier's instructions on the preservation of secrecy, during the phase of preparation and approach marches of the German Forces, whilst the enemy was preparing the two latest offensives. From these instructions we extract the following item, which will not be without significance and interest to Wireless men.

After emphasizing the necessity of officers alone being in possession of any papers or maps marked 'secret,' Von Hutier proceeds :—

> No secret affair is to be discussed over the telephone, as the enemy can hear conversations for seven miles behind the German front line. No telephonic installations are to go further forward than the posts of commandants of sectors, and all other telephone lines are to be dismantled.

Death of an Eminent Scientist.

We have to record the death, at 68 years of age, of Dr. Ferdinand Braun, one of the most prominent German scientists of modern days, and a notable expert and inventor in Wireless Telegraphy. Dr. Braun's decease took place at King's County Hospital, Brooklyn, New York, on April 21st last. The eminent professor visited America in 1914 to give testimony in a Patent Law action, and found himself unable, after the outbreak of war, to return to his own country. His investigations into radiotelegraphy extend over a great many years, and in December, 1910, he shared with Senatore Marconi the honour of receiving the Nobel Prize for Physics. His death marks the close of a career of eminence in the world of Wireless.

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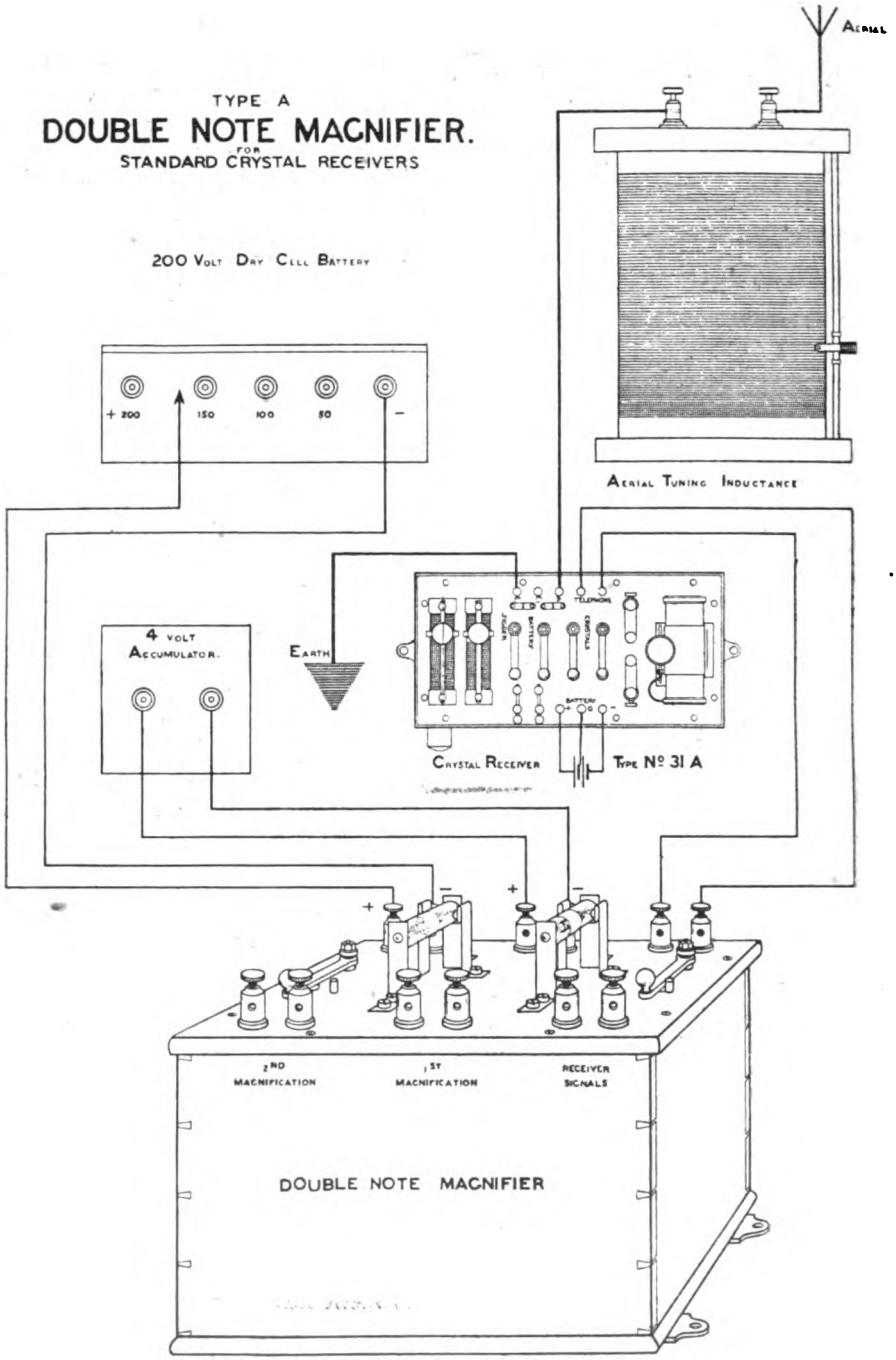

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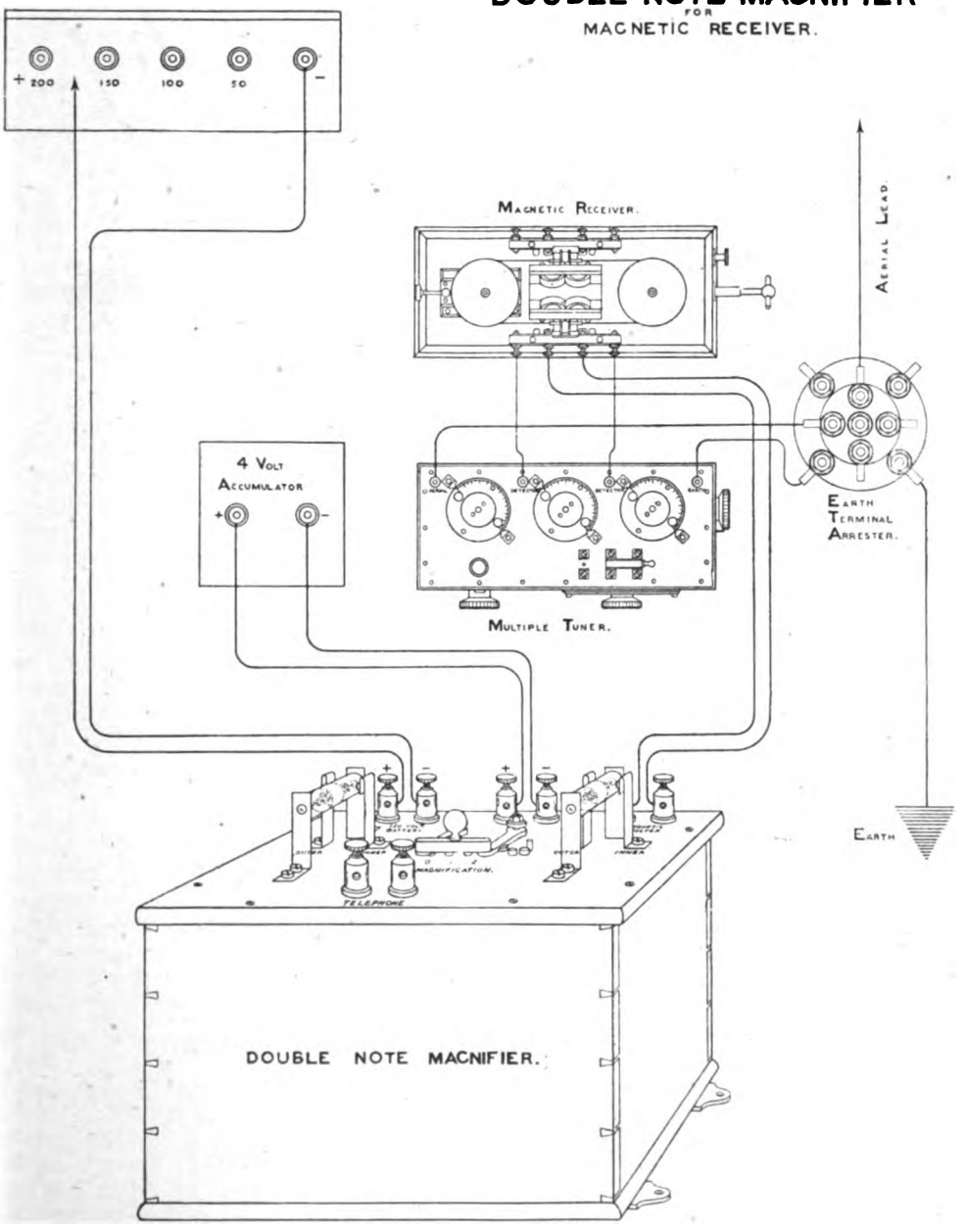
TYPE M.

DOUBLE NOTE MAGNIFIER

FOR

MAGNETIC RECEIVER.



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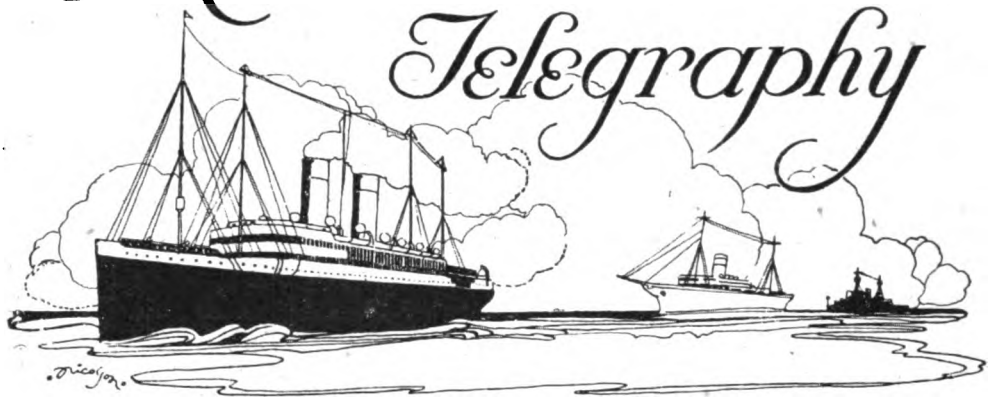
Maritime Wireless Telegraphy



Convoys.

In the days when the safety of our shores was guaranteed by "the wooden walls of Old England," when "posting" by relays of horses was the most expeditious method of conveying men and messages by land, whilst fast-sailing frigates fulfilled similar functions at sea, our ancestors found it necessary to convoy their merchantmen to and from our harbours. In those days almost every trading vessel carried guns, and many were the doughty battles which were fought with enemy frigates or privateers. The great East Indiamen, as the ships trading with Hindustan were called, carried nearly as powerful an armament as men-of-war.

The old order changed, and men believed those days to have passed away for ever. But the hands of Time, like those of a clock, revolve in a circle; and we have once more returned to the conditions of a hundred years ago. We do, however, "wear our rue with a difference." Perhaps one of the most striking points of that difference consists of the introduction of wireless telegraphy. Think for a moment what this means to the naval shepherd in charge of the flock.

At the time when Nelson was blockading Cadiz he was obliged to establish a line of signal vessels to link him with his most advanced scouts. Over a distance of but fifty miles it took two hours and a half for the admiral to receive information that the enemy was putting to sea. The naval officer in charge of a convoy was similarly obliged to maintain his communication with the merchant vessels under his charge by means of fast cruisers; and these cruisers themselves possessed no other means of exchanging orders and information than flag signals by day and flashlights during the hours of darkness. Even in pre-submarine times the disadvantages of the latter were proved by experience over and over again. To-day signal flashing might entail fatal results.

Again, if the convoying of a fleet of merchantmen is to be adequately carried out, the whole miscellaneous collection must manœuvre in unison, and failure in this respect was mainly responsible for these "cuttings-out" of convoyed ships which figure so largely in fictitious and real adventures at sea a hundred years ago. To achieve the desired result, at the present time as in days of old, before leaving port, the masters of the merchant ships meet the officers of the escort in conference, and are carefully drilled by them with regard to the station of each vessel, the order of sailing, and details of route and speed. To ensure uniformity of signalling each unit must carry a trained signaller, and an experienced R.N.V.R. man is usually placed for this purpose on board.

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Station keeping is comparatively easy for a squadron of battleships. In the first place they are in the habit of working together, and in the second place they are able to retain a few spare knots "up their sleeve" for an emergency or sudden order. But station-keeping in a convoy of merchant ships, differing in shape, tonnage, and speed, presents a totally different proposition. The strength of a chain is that of its weakest link, and the speed of a convoy that of its slowest member.

In an account recently published by one of our contemporaries we find two cases of ships dropping astern because the knottage of the vessel had been wrongly estimated. In another instance a vessel was observed to be miles behind her proper station and the commodore had to find out why. An interchange of wireless revealed that she was suffering from a leaking condenser, a matter which could be remedied in a few hours. She promised to be in station on the midday following, and kept her word.

The strain upon the king's officers in charge must be heavy indeed. The novels of Marryat and similar sea books of early nineteenth-century adventure abound in examples of critical situations and the "language" which they brought forth. Wireless telegraphy has materially lightened the strain, but those of us ashore, who owe so much to them, may well give a thought, from time to time, to these young men, but little past their boyhood, carrying on their anxious "watch," answering the wireless messages, and turning on the signalman to flash short concisely worded communications to consorts and convoys as occasion arises.

A vivid sketch of what goes on recently appeared in the public Press from a special correspondent who took part in a convoying cruise. The following extract may serve to indicate the intensity of life under such conditions:

> Despite the utmost care lavished upon them, our charges had straggled and were covering a wide distance.

Crew of "Aurora," a relief ship to the Shackleton Expedition to the Antarctic, at Port Chalmers prior to her sailing on her last voyage to the South. Operator Condon (central figure with stick) paid a send-off visit to this famous Polar exploration vessel.

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"Cannot effectively screen you if you scatter like this," we signalled.

An SOS from a hospital ship caused a momentary bustle, and a hasty calculation of her position. She was at least two hundred miles away, and, therefore, beyond our aid; but in a few minutes another wireless message arrived cancelling the SOS. This made us more easy in our minds, for it showed that the wild beast of the High Seas had once again been baulked of his prey.

Another marconigram announced the sinking of a small Norwegian vessel, and the rescue of her crew not very far away. Still another told of heavy fire west of ——, but this proved to be a patrol sinking a floating mine.

It was not "for fun" that the British authorities issued the orders that every vessel under their jurisdiction above 1,600 tons should be equipped with radio-telegraphic gear.

Again, apart from the regular daily routine of keeping the flock of convoys together, "Wireless" facilitates to a remarkable degree the "rendezvousing" which is necessary from time to time. We read a short while ago in our daily papers an account of the sinking of a "super U-boat" by a British submarine. The destroyed craft was one of those units upon which the German Navy specially prides itself, and silence on the part of our own authorities had rather led the public to believe that we ourselves were behindhand in respect of such vessels. But the fact that the British underwater craft was, according to the Admiralty announcement, *proceeding to meet a convoy* leads to a legitimate inference that our surmise was not justified, and that British cruising submarines, like other sea-going craft, are utilised to strengthen the protecting force of convoys at certain points. Now, in pre-wireless days such a vessel would have to cruise about in the previously arranged track of the convoy until she actually sighted those for whom she was waiting. Under wireless conditions, communication may be established at quite a long distance away, and the newcomer can proceed straight to her goal. The same factor holds good also with regard to any merchantman which from some cause or another has to drop out of her place and lose sight of the rest. So soon as she has repaired damages, she can advise the fact by radio-telegraphy, and learn through the same medium how to place herself as speedily as possible once again under the wing of the protecting squadron.

It is a strange and stirring picture for us to visualise, this revictualling of the Homeland and her resupplying with the necessaries of life. The task is difficult and arduous enough as matters stand; and it is scarcely too much to say that only radio-telegraphy renders possible and effective such a resuscitation of old-time methods for safeguarding the conveyance of supplies vital to our commissariat and industrial activities.

Paper Shortage

THE stringency of war conditions continues to increase progressively, and, in common with the rest of our contemporaries, THE WIRELESS WORLD is confronted with the necessity of instituting fresh economies with regard to paper.

A reduction in our number of pages proved inevitable, and we found ourselves confronted with two alternatives:—

(*a*) That of slightly closing up our lines and getting a larger number of words into each page by printing a little closer; and

(*b*) That of leaving the printing as it is and curtailing the reading matter.

We have chosen the former alternative, which will enable us to provide practically the same amount of illustrations and text as heretofore, and feel sure that the course will meet with the general approval of our friends and subscribers. Readers will be able to see for themselves from this issue how little the appearance of the magazine is affected.

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The Evolution of the Thermionic Valve (IV.)

By R. L. SMITH-ROSE, B.Sc., A.R.C.S., D.I.C., Student I.E.E.

Read before the Students' Section of the Institution of Electrical Engineers on January 22nd, 1918.

NOTE.—The first part of this valuable paper appeared in our April issue, pp. 10 *et seq.*

(5) THE PURE ELECTRON DISCHARGE VALVE (*continued*).

IN ordinary use the temperature of the filament is so low as to prevent any appreciable evaporation or deterioration, giving the tube an almost unlimited life.

Dr. S. Dushman* has described other forms of the kenotron used for the rectification of alternating currents. These can be constructed with a thermionic current carrying capacity up to 0·5 ampère, the filament being run at a temperature in the neighbourhood of 2,500° K., at which the life of the valve is approximately 2,000 hours.

Since the characteristics of the kenotron are positive and perfectly stable, several of these can be run in parallel, and each one will take its proper share of the current. By this means the rectification of very large currents can be carried out. In his paper Dushman reproduces some oscillograms which show the limitation of the thermionic current, firstly by the potential applied to the anode, and, secondly, by the temperature of the cathode. These oscillograms also show the perfect rectification obtained with this type of valve. A typical form of the kenotron for use up to 50,000 volts is illustrated in Fig. 13, the filament being mounted between two parallel plates, together forming the anode ; this arrangement is used in order to balance as far as possible the electrostatic forces between the anode and the filament, which may become very great at high voltages, and tend to pull out and break the filament.

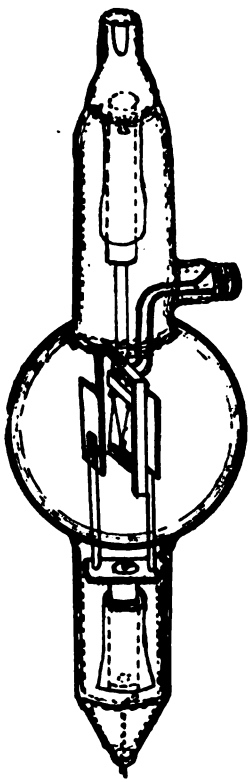

FIG: 13.

The general construction and use of the pliotron, containing three electrodes, is described by Dr. Langmuir in his paper before the American Institute of Radio Engineers in April, 1915,† and also in the patent‡ covering this invention. The general arrangement of the three elements is very similar to that employed in the De Forest audion, the details being modified according to the use for which the valve is required. The filament is of tungsten wire and is usually either in the form of an inverted V or stretched straight between the supporting wires. The second and third electrodes are of nickel wire and plate respectively, and with the V-shaped cathode are arranged on either side of this in parallel planes as illustrated in Figs. 14 and 15. In the other form the grid is formed of a cylindrical spiral of nickel wire around the filament as axis, the plate forming a co-axial cylindrical sheath surrounding both grid and filament.

* S. Dushman (*General Electric Review*, March, 1915 ; *Electrician*, lxxv., p. 276 (1915)).
† I. Langmuir (*General Electric Review*, May, 1915 ; *Electrician*, lxxv., p. 240 (1915)).
‡ British Patent 15,788, 1914.

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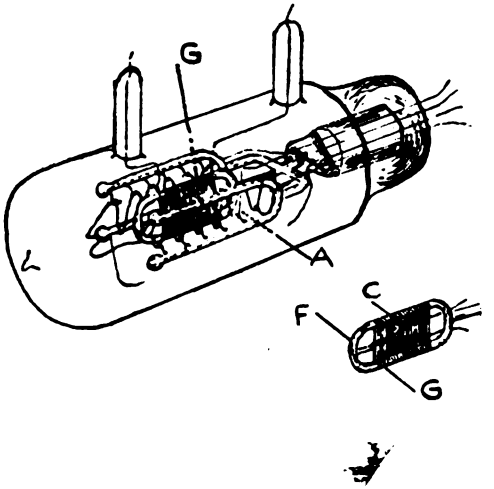

FIG. 14

When these elements have been mounted in the tube the latter is evacuated by the most approved methods of electric lamp exhaust, using either the Gaede molecular air pump* or, better, the mercury condensation pump as developed by Langmuir.† The first evacuation is carried out with the whole valve heated in a suitable furnace to the highest temperature that the glass will stand without softening, in order to remove as much as possible of the gas and vapour occluded on the walls of the vessel. It is desirable, too, that all the electrodes should be heated electrically if possible to a temperature of about 2,500° C. But this heating alone will not remove all the gas, and the first electron discharge to which the tube is subjected will liberate a considerable amount of gas from the surface of the metal. To complete the evacuation to the required degree, the pump is maintained continuously operated while the tube is subjected to an electron discharge between cathode and anode at a voltage which is gradually increased to a value somewhat greater than the normal working voltage of the valve. Care must be taken at the commencement of this operation not to use a voltage sufficient to cause the blue glow effect which will result in disintegration of the cathode; but towards the end of the operation the electronic bombardment of the anode must be very intense in order to completely free the metal electrodes from occluded gas.

By this means the bulb is exhausted down to a pressure of the order of 1/100,000 millimetre of mercury, and no deterioration of this vacuum takes place during the normal operation of the valve.

As has been previously pointed out, the characteristics of this type of valve are perfectly smooth and regular, and quite free from all the disturbances and points of instability which often accompany the other types of gas-filled valves.

The characteristics of the pliotron depend upon the length of filament used, the distance between filament and grid, the spacing between the grid wires, the diameter of the grid wires, the distance between grid and anode, and the size and shape of the anode.

The important characteristics of a pliotron to be observed are, first, the variation of the current flowing between the anode and cathode with the potential on the anode and with that on the grid, and, second, the variation of the current flowing to the grid with the same potentials of anode and grid.

The characteristics of a pliotron of the type shown in Fig. 14 are shown in the diagram, Fig. 16, the curves showing the variation of the current flowing to the plate and grid as the voltage on the grid is varied, while the anode potential is maintained constant at 220 volts. For different potentials

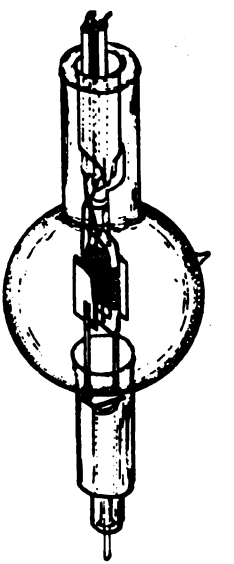

FIG. 15

* *Engineering*, xcvi., p. 379 (1913).
† *The Electrical Review* (London), lxxx., p. 41 (1917).

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applied to the anode, these curves are shifted vertically, by amounts proportional to the change in anode potential. Dr. Langmuir has found that these curves can be approximately represented by the formula :—

$$i = A\,(Va + kVg)^{\frac{3}{2}}$$

where i is the current flowing to the anode, Va is the voltage on the anode, Vg the voltage on the grid, and k and A constants which depend upon the dimensions of the valve and the relative shapes and positions of the electrode.

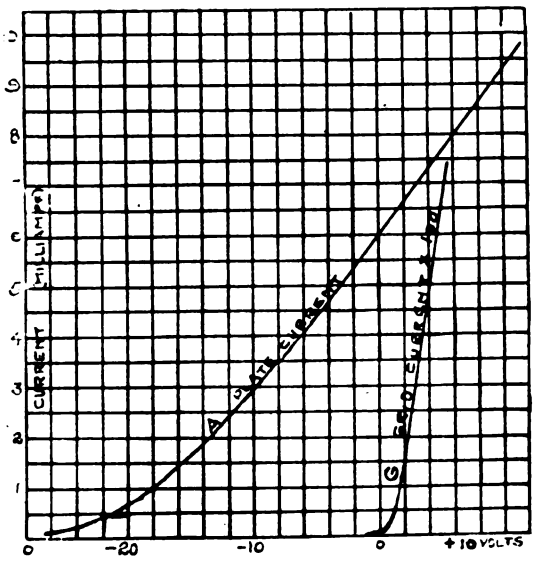

FIG: 16

In order to pass through the vacuum the currents at which this type of valve normally operates, the potentials which must be applied to the anode are considerably greater than those used in the case of the audion, but, if it be necessary, one can increase the voltage up to several thousand, without any evidence of positive ionisation, such as the blue glow effect being observed.

Owing to the extensive commercial use of thermionic valves for various purposes at the present time, there is naturally considerable development and improvement continually going on, but it may safely be said that all the valves in use belong, in principle, to one or other of the types described above. A review, by Dr. W. H. Eccles, of the recent patents applied for on this class of apparatus shows that the chief improvements which have been made are slight modifications in the arrangement of the electrodes and also alterations in the operating circuits to obtain increased sensitiveness.*

(*To be continued.*)

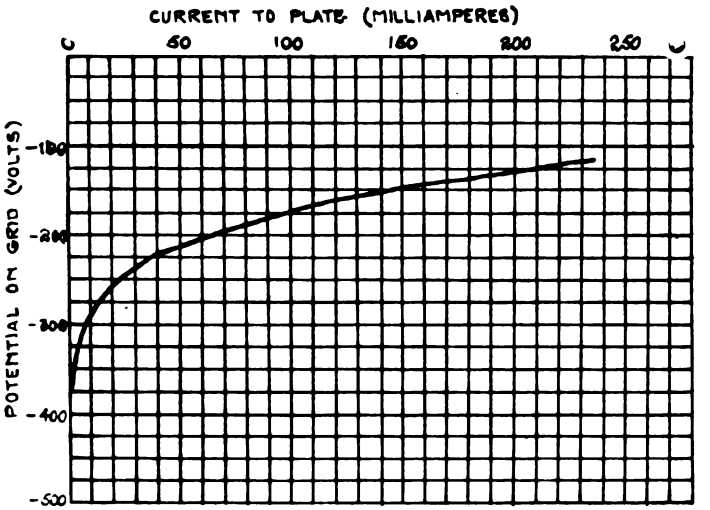

FIG: 16 A

* W. H. Eccles, *Electrician*, lxxvii., pp. 571, 594 (1916).

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Among the Operators

It is our sad duty month by month to record the deaths of the brave operators who have lost their lives at sea by enemy action, and other causes, in the wireless service of their country. Owing to the necessity of preventing the leakage of information likely to assist our adversaries, the names of ships and localities of action cannot be published. With the exception of Mr. M. J. McGrath, taken prisoner, and Mr. D. P. Smart, who is in hospital at New York, the lives of the operators whose photographs we publish this month have been sacrificed as the result of hostile activities. Both on our own part, and on that of our numerous readers, we extend to the parents and relatives of these young men, who so nobly uphold the "wireless tradition," the deepest sympathy in their sad bereavement.

Mr. PHILIP DANIEL BOLT, who was born at Forest Gate, was eighteen years of age, and received his education at George Green's School, Poplar, and at the High School, Southend-on-Sea. On completing his education he took an interest in wireless telegraphy, and entered the Marconi Company's School, for training. On completing his course and receiving the P.M.G. Certificate he was appointed to the operating staff in November, 1916.

A Lancashire lad, Mr. JAMES CRAWSHAW was born at Worsley in 1900. Educated at Deykin Avenue Council School, Witton, Birmingham, and Lewis's Street Council School, Manchester, he was employed by the Wolseley Sheep Shearing Machine Company, Limited, Birmingham, in a clerical capacity after leaving school. Trained in wireless telegraphy at the City School of Wireless Telegraphy, Ltd., Birmingham, he qualified for the P.M.G. Certificate, and received an appointment in the Marconi Company in March of this year.

Mr. WALTER HERBERT OLIVER was born at Tibbermore, Perthshire, on January 8th, 1900, and went to the Ferryhill Public School for his education. Commencing his career in the Post Office, he was appointed messenger at Aberdeen, and from there entered the Scottish Wireless College, Aberdeen, where he was trained in wireless telegraphy. On gaining the P.M.G. Certificate Mr. Oliver was placed on the Marconi Company's operating staff in March, 1917.

Born at Cleckheaton, Yorkshire, on January 26th, 1899, Mr. GEORGE RONALD SLACK pursued his studies at the Wakefield Grammar School. He then entered the service of the Lancashire and Yorkshire Railway Company as junior clerk in the office of the goods superintendent at Wakefield, and was so employed until he commenced training at the North-Eastern Schools of Wireless Telegraphy, Leeds. After being granted the P.M.G. Certificate Mr. Slack joined the Marconi Company's service in May, 1916.

Mr. ERNEST DAVID MORRIS, who hailed from St. Asaph, was born on March 17th, 1902, and received his schooling at Candottan Council and the Neath County Schools. Wireless telegraphy having a great attraction for him, he successfully studied under the tutelage of the South Wales Wireless College, Ltd., at Swansea, and was awarded the P.M.G. Certificate. Mr. Morris joined the operating staff on January 21st, 1918.

News is to hand that Mr. MAURICE JAMES MCGRATH has been taken prisoner by the Germans. Mr. McGrath joined the service in 1916, and served on several ships previous to the one from which he was captured, presumably by a submarine. As previously mentioned in our pages, a number of Marconi telegraphists are interned at the Ruhleben Camp, in Germany, so that we trust Mr. McGrath may meet friends, and his captivity thus be lightened.

Advice has been received that Mr. DAVID PEARSON SMART, who left England for the United States and joined a ship in New York last December, was taken ill

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ROLL OF HONOUR.

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shortly afterwards, and removed to hospital to undergo an operation for appendicitis. We trust this has been successfully performed, and wish him a speedy recovery.

GRATUITIES TO OPERATORS.

In our May issue, under "Maritime Wireless Telegraphy," we referred to "The Merchant Ships' Gratuities Committee," which sits at the Admiralty, and awards sums of money to merchant officers and seamen for devotion to duty when in action with enemy forces. We have pleasure now in printing the names of 60 operators whose conduct has been recognised in this way by the authorities to date:—T. F. Alton, J. Angas, A. Arklay, S. Austin, A. Beatty, C. Bovey, P. P. Brehoney, F. J. Bruce, A. T. Campbell, Thomas Carney, W. J. Charles, W. S. Crabbe, A. E. Cruse, P. Crawley, A. R. Day, J. T. Dunbar, H. B. Elder, S. G. Evans, J. F. A. Ford, E. W. Gardiner, G. C. Gaughan, W. F. Gray, P. J. Harrington, S. A. Henderson, J. K. Holland, G. Hutchinson, G. H. Jarrett, J. A. Johns, T. Killeen, J. V. Kinnimonth, R. H. Lea, D. S. Lewis, A. McNair, G. D. Martin, H. C. Masters, G. Midgley, J. Montgomerie, J. Mongey, W. T. Munro, M. W. Murphy, W. J. C. Murray, A. A. Newbery, F. A. Nixon, G. O'Hallaran, E. P. Pearce, F. Pearson, R. Priestley, E. Rattue, M. Santuy, M. Shea, J. Shearer, H. Smith, H. Sneath, J. Vincent, N. Walton, T. Ward, H. J. West, J. Whittaker, C. W. Wilde, E. N. M. Wroughton.

New Wireless College at Auckland

THE most recent manifestation of radiotelegraphic activities in the Australasian Dominions consists of the official opening and installation of the Marconi wireless apparatus at the Dominion College of Radiotelegraphy in Auckland, the capital city of the North Island of New Zealand. The ceremony of initiation was recently performed by the Rt. Hon. Sir Joseph Ward, Postmaster-General and Minister of Telegraphs.

In the course of an interesting speech made on that occasion, Sir Joseph stated that this college, in common with others, had for a considerable time been working under difficulties, inasmuch as it found itself *minus* the necessary equipment, and —under the war regulations—this could not be installed until special permission had been obtained. Official leave was finally granted, and arrangements were made with the Amalgamated Wireless, Ltd., for the installation of four complete sets of Standard 1½ kw. Marconi apparatus. Provision had also been made for giving students at the Dominion College priority for appointments to the Amalgamated Wireless operating staff. The college was incorporated as a private company on February 23rd, 1917, and—in the course of the first year—250 pupils had received instruction; 80 students having taken up appointments, for the most part in war work. During the last twelve months four of the latter had made the supreme sacrifice, and laid down their lives for the Empire.

The eminent New Zealand statesman proceeded to give a brief summary of the history of wireless telegraphy, and enumerated a number of examples indicating the wonderful development of the science under the stimulus of war conditions. He expressed the opinion that before many years wireless telephony would have come into her own, and would have reached the stage of universal use. He wound up by congratulating the directors and managers of the college upon the enterprise and efficiency displayed by them, pointing out that efforts such as theirs not merely redounded to their personal credit, but constituted valuable assets in the progress of Imperial Development.

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Instructional Article

NEW SERIES (No. 4).

EDITORIAL NOTE.—Below we give the fourth of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

PHYSICS FOR WIRELESS STUDENTS.

Law of Inverse Squares.—Every body attracts every other body with a certain force the direction of which is that of a straight line joining the bodies; the same statement applies to the *particles* of matter. The law of inverse squares, which has a wide application in physics, is a more precise expression of the law governing this force and may be stated as follows. **For small bodies the force of attraction is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.** This, expressed in symbols, is usually written:

$$F \propto \frac{m_1 m_2}{d^2}$$

where m_1 and m_2 are the masses, d the distance and F the force. If the masses are equal, $F \propto \frac{m^2}{d^2}$, m being the mass. In order to change the formula to an equation a constant must be introduced and the full expression is then

$$F = k \frac{m_1 m_2}{d^2}, \; k \text{ being a constant.}$$

Inverse Square Law for Electric Charges.—Two positively charged bodies repel each other with a force which is determined by the inverse square law:

$$F = K \frac{Q_1 Q_2}{d^2}$$

where Q_1 and Q_2 are the charges and K is a constant depending on the nature of the medium separating the bodies. *Numerically*, K in the present case is equal to the reciprocal of the dielectric constant of the medium and the equation can be written

$$F = \frac{1}{k} \frac{Q_1 Q_2}{d^2}$$

where $\frac{1}{k}$ represents K, k *being the dielectric constant.* If the medium is air or aether the dielectric constant is taken as 1 and the equation becomes

$$F = \frac{Q_1 Q_2}{d^2},$$

d usually being expressed in centimetres and F in dynes.

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If the charges are equal, d is 1 cm., and F (in air) is 1 dyne, then the charges are *unit charges*. From this the reader will be able to express for himself the definition of unit electric charge.

If the dielectric be other than air or aether F is less than it would be for those media. A comparison will make this clear.

(1) When dielectric is **air,**

$$F=\frac{1}{k}\frac{Q_1Q_2}{d^2}\text{ dynes}=\frac{1}{1}\frac{Q_1Q_2}{d^2}\text{ dynes.}$$

(2) When dielectric is **ebonite,**

$$F=\frac{1}{k}\frac{Q_1Q_2}{d^2}\text{ dynes}=\frac{1}{3\cdot15}\frac{Q_1Q_2}{d^2}\text{ dynes}$$

or (1) $$F=\frac{Q_1Q_2}{d^2}\text{ dynes,}$$

(2) $$F=\frac{Q_1Q_2}{3\cdot15d^2},$$

where $3\cdot15=k=$dielectric constant of ebonite. Clearly (2) will be of lower value than (1).

Inverse Square Law for Magnetic Poles.—If two similar and equal magnetic poles are placed 1 cm. apart in air and the force they experience is 1 dyne, then the poles are of *unit strength*. If m_1 and m_2 are strengths of two poles expressed in the unit just defined, then in air

$$F=\frac{1}{\mu}\frac{m_1m_2}{d^2}$$

where d is their distance apart and μ the *magnetic permeability* of the intervening medium. For empty space, air or other *non-magnetic* material μ can be taken as 1; for any one *magnetic* material the value of μ is not constant.*

As further examples of the application of the law of inverse squares the following may be noted.

Light.—The intensity of illumination due to a source of light considered as a point **varies inversely** as the **square of the distance** from the source.

Sound.—The intensity of sound due to a given source **varies inversely** as the **square of the distance** from the source.

FORCE (concluded).

It has been pointed out repeatedly that force is not a physical *thing* and stress has been placed upon this because too often the word force is invested with an incorrect significance. In advanced electrical and magnetic theory, in the region of "lines of force" and "tubes of force," this ultimately inexplicable "force" is apt to become rather materialised by sheer familiarity with the use of the word and the conventional, convenient diagrams, and it is just as well to remember that, physically, force is non-existent. In a physical action the important factor is the *energy* involved or *the work done*. Force is made manifest in many ways but its results are always the same—*i.e.*, to move or to change the movement of matter. Its immediate cause may be muscular, mechanical, chemical, electrical, magnetic or gravitational, but after a physical action has taken place the "force" **disappears;** but the energy, the conserved, enduring *thing*, only **changes.**

* To follow up this point read about magnetic permeability in a book on Magnetism and Electricity.

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MOTION.

Considerations of space and the elementary nature of these articles permit us to treat only of one form of motion, harmonic motion, which is the most interesting and probably the most important to the student of radiotelegraphy. It is worth while to point out that Nature presents a remarkable number of periodic phenomena and that many of these have influenced and continue to influence, because of their periodic nature, life on this planet from that of organisms far down the biological ladder to that of the human race. This influence can be traced in the laws, religions, and customs of men and even in the common round of our daily life and habits. The ebb and flow of the tides, the regular recurrence of the seasons, the alternation of day and night, the monthly " waxing and waning " of the moon, the pulsation of the heart, the rhythm of breathing, the sea waves, sound and light are all examples of periodicity in some form or other.

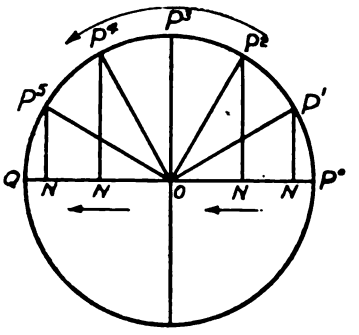

FIG. 15.

Simple Harmonic Motion.—Referring to Fig. 15, imagine that a point P, starting from the position P^0, moves round the circumference of a circle in a positive direction at an uniform speed. The centre O being fixed, the line OP will sweep out 2π radians during every complete revolution of P. Now suppose that P has reached the position P^1. A line has been drawn from P^1 perpendicular to OP° and meeting OP° at N; this point N is the projection of the point P^1 upon the horizontal diameter of the circle. It should be clear that before P begins to move from its position at P^0, ON will coincide with OP^0, that is to say, the projection of P upon OP^0, if it could be made, would be the point P^0. It should be equally clear that as P moves round the circumference to Q the point N will move towards Q along the diameter QP^0. Note in Fig. 15 the progress of N towards Q as P reaches P^1, P^2, P^3, P^4, P^5, and that P and N will evidently reach Q together. Note also that when OP has swept out 90° and P has reached P^3, the point N has reached O. The reader's attention is also directed to the fact that by the time OP has swept out 180°, that is, when it lies along OQ, N has travelled along the entire diameter from P^0 to Q.

In Fig. 16 we follow the continued movements of P and N. Both are moving back to the point P^0, but, whereas P is still moving in a positive direction, *N has reversed its direction of motion* and is moving back over its first track. When both points reach P^0, P has completed one revolution and N has performed one complete swing. As P continues to move round the circumference so N will continue to *oscillate* between Q and P^0.

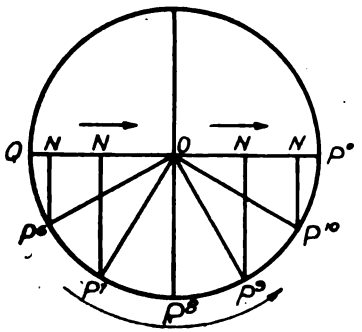

FIG. 16.

It was assumed that the speed of P is uniform, but it should be noted that the velocity of N is *not* uniform since *at the points Q and P^0* the direction of the motion of N is reversed, and the velocity *at the points Q and P^0* is zero, because before the *sense* of a velocity reverses there must occur a slowing down eventually resulting in a stoppage at the instant before the reversal takes place. In the unlikely event of the reader being unable to grasp this idea let him move a pencil backward and forward along a straight line at any velocity he pleases; he cannot then fail to realise that having reached one end of the

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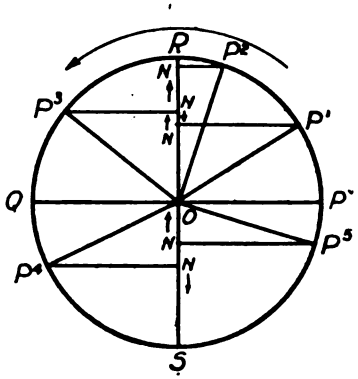

FIG. 17.

line the point of his pencil is bound to stop moving for a small fraction of time before it can "turn round and go back."

If instead of projecting P upon the horizontal diameter QP^0 we project it upon the vertical diameter RS (Fig. 17), N will oscillate between R and S. It is important to notice that

(1) In the case of the projection of P upon the horizontal diameter (Fig. 15) the point N is at the *beginning of its swing* when OP starts to move—*i.e.*, when it lies along OP^0.

(2) In the case of the projection of P upon the vertical diameter RS (Fig. 17) the point N is at O when OP starts to move, and is at the *mid-point* of a swing.

The point N, moving as described along the two diameters, is said to move with **Simple Harmonic Motion** and we can say that **the uniform motion of a point round the circumference of a circle can be resolved into two S.H. motions at right angles to each other.**

The chief characteristic of S.H. motion is that it follows a **sine law.** It is true that it can be represented by a *cosine* formula, but the difference is only a matter of phase and depends upon whether the time factor is considered to be zero when the moving radius OP is in line with the direction of the S.H.M. or when it is vertical to the direction of the S.H.M.

Case I.—See Fig. 18. The direction of the S.H.M. in this case is considered to be along the vertical diameter. If $t=o$ when OP lies along the horizontal diameter, as shown in the figure, then the S.H. motion is represented by a **sine formula.**

Case Ia.—By the simple sine law the distance from N to O measured along the vertical diameter is at any time proportional to the sine of the angle which has been swept out by OP, *time being taken as zero at the instant when OP lies along the horizontal diameter, that is, along* OP^0 (Fig. 18).

The angle swept out by OP at any time t is the **angular displacement** θ, which, it will be remembered, is equal to $2\pi nt$.

We have, then, $i \propto \sin\theta$, where i is used to denote any instantaneous value of the distance from N to O. In order to turn this expression into an equation we can write $i=k \sin\theta$, k being some constant. The constant actually employed is the *maximum value* which ON can reach, and this, as can be seen by examining the diagrams, is equal to that particular value ascribed to the radius of the circle, for ON can never be greater than the radius. To remind us what k represents it is convenient to call it I_{max}.

$$i = I_{max} \sin\theta \quad . \quad . \quad (1)$$

Let us test the truth of this equation. For simplicity we will make I_{max} equal to 1 and we will take θ as 30°, which is the angle swept out by OP in Fig. 18. Draw PN^1 perpendicular to OP^0 and PN perpendicular to OR. Now, we are trying to find the value of the distance of N from O along the

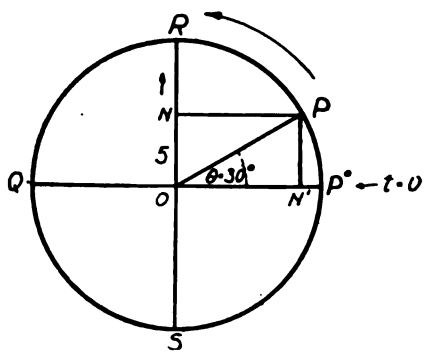

FIG. 18.

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vertical diameter at the moment when $\theta = 30°$, so that if $i = I_{max} \sin \theta$ then NO should be equal to $1 \times \sin 30°$. The sine of the angle θ is equal to the ratio $\frac{PN^1}{OP}$ and as PN^1 equals NO we can say that $\sin \theta = \frac{NO}{OP}$; but OP equals 1, hence $\sin \theta = NO$. The angle θ being 30° its sine is ·5 (a value which can be found in a table of sines), so that NO ought to equal ·5. By measurement on the diagram it will be found that this is so, taking OP as 1.

$$i = I_{max} \sin \theta$$
$$NO = 1 \times \cdot 5 = \cdot 5.$$

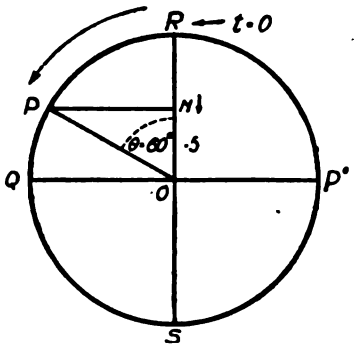

FIG. 19.

Hence at any instant, if t is considered to be zero when OP lies along the horizontal diameter, the value of NO on the vertical diameter is equal to $\sin \theta$, I_{max} being taken as unity.

Case II.—The direction of the S.H.M. is considered to be along the vertical diameter. If $t = o$ when OP is *in line* with the direction of the S.H.M. as shown in Fig. 19, the motion is represented by a **cosine formula.**

Case IIa.—The distance NO, measured along the vertical diameter, is at any instant proportional to the cosine of the angle which has been swept out by OP, *time being taken as zero at the moment when OP lies along the vertical diameter,* that is, along OR (Fig. 19).

$$i = I_{max} \cos \theta.$$

Again taking I_{max} equal to 1 it is seen (Fig. 19) that $\theta = 60°$. What we wish to find is the value of NO at the instant when $\theta = 60°$. Draw PN perpendicular to OR. Then $\cos PON = \frac{NO}{OP}$; but $OP = 1$, so that $\cos PON = NO$. The cosine of PON (60°) is ·5, therefore $NO = \cdot 5$. This can be verified by direct measurement on the diagram, taking OP as 1.

$$i = I_{max} \cos \theta$$
$$NO = 1 \times \cos 60°$$
$$= \cdot 5.$$

Hence at any instant, if $t = o$ when OP lies along the vertical diameter, the value of NO measured along that diameter is equal to $\cos \theta$, I_{max} being taken as unity.

In cases *I.* and *II.* we took $I_{max} = 1$; but if I_{max} should be greater or less than unity then i will be greater or less than the sine or cosine of θ.

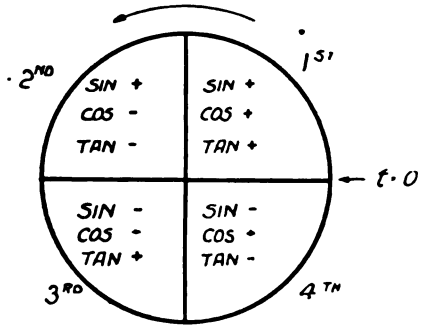

FIG. 20.

Twice during every revolution i will be *equal to* I_{max}, and its value at these times is called the **amplitude** of the motion.

It should be noted that in practical examples θ is generally expressed *in radians,* so that if the reader is dealing with an equation of the form

$$i = I_{max} \sin 2\pi nt$$

he will have to multiply $2\pi nt$ by 57·3, thus obtaining the angle in degrees. He can then find the required sine from his tables.

To go fully into the cases where θ is an angle in the second, third, or fourth

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quadrants would encroach too much upon the subject of mathematics but the student is advised to manufacture examples of such cases and to work them out, giving various values to I_{max} and θ. For reference during such work Fig. 20 shows the signs of the trigonometrical ratios in all quadrants.

Sine Curve.—A simple sine curve is the curve of the equation $i = I_{max} \sin \theta$, which is sometimes met thinly disguised as $y = a \sin (cx + g)$ or an equation of similar form but with different letters. The two forms are, however, just two ways of expressing one fact. Fig. 21 shows a sine curve (A). It was obtained by taking various values of t and finding the corresponding values of i above and below o. Above and below the base line these values of i were indicated by lines drawn from the points marking the corresponding values of t. The tops of the lines were then

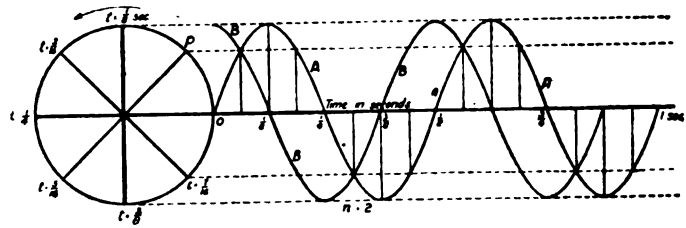

FIG. 21.

joined by the curve. A cosine curve (B) has been drawn in the same diagram in order to show graphically that it is of exactly the same type as the sine curve, but that it *leads by a quarter-period*. The full period in this case is half a second, OP making 2 r.p.sec.

The current in an alternating current circuit can be represented by a sine curve, in which case i means "the current in the circuit at any instant t"; or i may be the instantaneous value of an alternating E.M.F. A sine curve may also represent undamped H.F. oscillations. The reader should make an exhaustive study of these curves, actually drawing them on squared paper, obtaining his ordinates (*i.e.*, the distances of the curve above and below the base line at various times) both by calculation from the equations and graphically by taking various positions of OP.

(To be continued.)

German Post-War Preparations

A STATEMENT recently appeared in the *Neue Hamburgische Borsen Halle* to the effect that:

A company, under the style of Drahtlose Ueberseeverkehr, A.G. (oversea Wireless Communication Company), has been formed at Berlin with a capital of M.10,000,000 to establish a wireless news service. The main station at Nauen will be utilised in the new undertaking. The board of directors includes Count von Arco, Dr. Franke (director of Siemens-Schuckert works), Herr Heinemann (director of the Deutsche Bank), Councillor of Commerce Mamroth (Algemeine Elektrizität Gesellschaft), Herr Müller (Councillor of the Finance Board of the Dresdner Bank) and Herr Hans Bredow.

This announcement goes to form a fresh indication of the seriousness of our enemy's intentions with regard to the establishment of a Teutonic "Lloyd's" after the war, to which we referred on page 260 of Volume V. British shipping men, and, indeed, all concerned in this vital industry, will do well to take the menace very seriously indeed.

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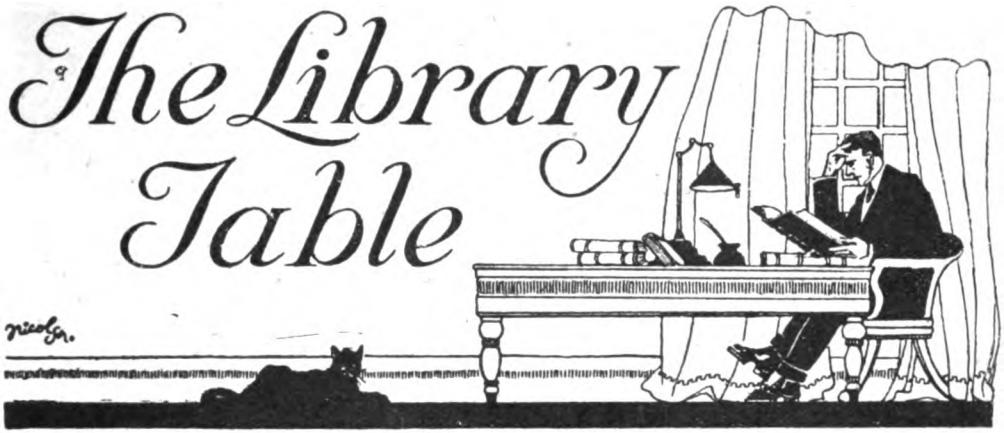
The Library Table



THE SHIPPING WORLD YEAR BOOK, 1918, *edited by E. Rowland Jones. Published by "The Shipping World," Arundel Street, Strand, W.C. Price* 10s. *net.*

Amongst the various annual publications devoted to special branches of industry the *Shipping World Year Book* occupies an honourable and assured position. The volume which has just come into our hands is the thirty-second edition issued by the Press of Effingham House; and the only adverse remark we have to make is that—owing, doubtless, to superabundance of matter—the editorial text occupies no fewer than 2,066 pages; with the result that the volume "bulks" somewhat in handling.

The variety of information contained in this and similar volumes is too often overlooked; it has frequently fallen to the lot of the present writer to be asked some question quite impossible for him to answer "out of hand," and which the inquirer could just as easily have turned up for himself in works of reference open to all. The shortcoming of individual initiative lies, of course, in a failure of sufficient acquaintance with the material for reference available.

The *Shipping World Year Book* centres round two principal features:—(*a*) A Port—and Harbour—Directory, covering the whole world; and (*b*) the Tariffs of all Nations. These two leading features are brought up to date annually, and, we presume, constitute the items which are recalled by the mind of every consultant whenever occasion arises for the information to be sought, and memory stirs some recollection of what is to be found between its covers. But there are a large number of miscellaneous items which in their way are just as useful from the point of view of reference.

We notice, for instance, Conversion Tables for foreign weights, measures, and money; as well as tabular matter connected with the compass; weather, and degrees of latitude and longitude. A place is found for the Board of Trade Tables of Free-Board, together with the rules and instructions for applying them, and we are furnished with the text of British regulations affecting load-lines, and the rules of international classification. A digest of the various Merchant Shipping Acts occupies 155 pages; whilst the Aliens Act, the Factory and Workshop Act, the Workmen's Compensation Act, and that part of the National Insurance Act which applies to the Mercantile Marine, are given in full. We find, moreover, a number of miscellaneous items, such as the fees and other arrangements affecting Masters' and Mates' Certificates; Seamen's Discharge and Naturalisation Certificates; the Standing Rules for vessels at sea and in port; an explanation of ships' tonnage, and a list of His Majesty's Consular Certificates Abroad. The List of Customs

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Boarding Stations undergoes an annual revision ; and a number of tables, such as those of distances, time and knot, coal consumption, etc., combine with the aforementioned features to complete an extremely handy book of reference.

The Shipping Map of the World, contained in a pocket fitted to the back cover, is printed in colours ; and shows the various regular steamship routes, marked as clearly as is possible with so complex a nexus. We notice, by the way, that the vast territories still included under Russian Rule continue to be labelled " Russian Empire," a term more redolent of Tsardom than of present conditions.

"RADIOTELEPHONY." By Alfred N. Goldsmith, Ph.D. New York: The Wireless Press, Ltd. Inc. $2.00.

Radiotelephony, strangely enough, has never taken any great hold upon the popular imagination. This is the more remarkable, seeing that the transmission of speech through ether without any connecting wire is really a far more wonderful achievement than the sending of dots and dashes. This oversight on the part of the public may be due in a large degree to the measure in which radiotelephony has been overshadowed since its inception by its elder sister, radiotelegraphy, in whose track it has so closely followed.

So far as technique is concerned radiotelephony is closely allied to its sister art, the fundamental principles underlying both branches of radio activity being the same. Thus both utilise high frequency oscillations, both make use of ether waves for the transmission of their signals ; while for reception purposes the methods of the two sciences are so nearly identical that one may receive the signals of the other. The student, therefore, who sets out to master the principles of radiotelephony has his path cleared of all preliminary obstacles if he possess a previous acquaintance with the technique of the wireless telegraph.

Whilst every standard manual of wireless telegraphy has its chapter or chapters briefly outlining the principles and progress of the wireless telephone, we have hitherto lacked an authoritative manual dealing exclusively with modern radiotelephony. In making this statement we are far from desiring to cast any aspersion upon the well-known treatise of Ernest Ruhmer, so ably translated by Dr. Erskine Murray. That work, excellent so far as it goes, was written long before any of the modern methods were introduced.

It has fallen to the lot of America, ever well to the fore in wireless research work, to produce such a book as that which is required, and all wireless men will give a hearty welcome to Dr. Goldsmith's treatise. The book is designed on an excellent plan, and we are glad to find the first chapter devoted to a consideration of the uses of radiotelephony, including a comparison of the wired and wireless forms of speech transmission, and the broad problems involved in radiotelephony.

At this point it may be advisable to point out that, in order to obtain the fullest benefit from the book, it is necessary for the reader to have some acquaintance with the principles and practice of radiotelegraphy. Had the author not assumed such knowledge to be possessed by his readers, the present volume would inevitably consist largely of a recapitulation of previously published work—a method of duplication not to be desired from any point of view. Chapters II., III., IV. and V. are devoted to the various forms of sustained wave generator used in wireless telephony. Here we find collected together for the first time full descriptions of modern Poulsen arc apparatus, radio-frequent spark systems, vacuum tube oscillators, and high frequency alternators. Any student who approaches radiotelephony for the first time through Dr. Goldsmith's treatise will be surprised at the multiplicity of devices for obtaining sustained waves ; and we feel sure that there are but few, even amongst wireless men of experience, who realise the amount of research work which has been devoted to this branch of the art.

For several years scientists have been well acquainted with a number of methods

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of producing continuous waves suitable for the transmission of speech, but it is only quite recently that they have been able to modulate the radiated power in accordance with the sound waves of the voice. The energy controlled by the microphone in the ordinary wired telephone is in the order of micro watts; but, if we wish to radiate ether waves modulated to carry wave formation of speech, we must be able to employ other means of varying the heavier powers. In chapters VI., VII. and VIII., Dr. Goldsmith deals with this side of the question, the crucial problem of radiotelephony, and shows how the difficulties in the way have been overcome. This has been effected very largely, as a matter of fact, by means of amplifiers. The formidable character of the problem which faces us in this direction will be realised when we consider that the transmission of a single word over a long distance by radiotelephony requires that the speech of the operator should cause a momentary variation of several kilowatts in the aerial!

The section dealing with oscillation valves is particularly well treated, and although the author wisely refrains from touching upon such controversial points as priority of invention, he is yet able to do justice to much of the work of the numerous inventors in this field. We find, for example, a fuller recognition of the work of Captain H. J. Round than is usually given in text books. This inventor, together with A. J. Franklin, has contributed far more to the development of the three electrode valve than is customarily acknowledged, and we are glad to notice that Dr. Goldsmith has recognised their claims.

The recently introduced high-vacuum valve of the General Electric Company, known as the *pliotron*, and the circuits designed to work with this instrument, receive adequate treatment and illustration. A comprehensive description of the still later "dynatron" also finds a place. This device depends on a principle hitherto not utilised in this connection, namely, secondary emission; and our author's explanation of its working is interesting in the extreme. When employed as an amplifier, voltage amplification to the extent of a thousandfold has been obtained, and one hundredfold amplifications are readily available. When employed as an oscillator, the dynatron has shown itself capable of producing all frequencies between less than one cycle per second and 20,000,000 cycles per second (corresponding to a wavelength of 15 metres). The output of a single bulb has been as much as 100 watts.

In the final chapters the Author deals with aerials and ground connections, reception phenomena, and radio-phone traffic in general, while the book concludes with an index of investigators and topics, exceptionally well compiled.

We cannot conclude our remarks without some reference to the numerous excellent illustrations, both photographic and diagrammatic. These are numerous and important, and we would suggest that the Author might well consider in any future edition the advisability of including a list of illustrations for reference purposes. As a whole, the volume is excellently produced, and this suggestion constitutes the only corrective criticism which we have to offer.

"THE AVIATION POCKET BOOK FOR 1918." *By R. Borlase Matthews, A.M.I.C.E., M.I.E.E., F.Ae.S. Sixth edition. London: Crosby Lockwood & Son.* 6*s. net.*

The well-deserved popularity of this excellent annual will undoubtedly be enhanced by the publication of the 1918 edition now before us. In itself it constitutes no mean achievement under the present *régime* of rigid censorship, to have been able to produce an Aviation Pocket Book combining practical and useful knowledge with interesting and up-to-date reading matter. The success, therefore, of this handy volume forms the subject of well-deserved congratulation to all concerned in its production.

So far as general design is concerned, the new edition follows closely upon the model of its predecessor, although we notice that a certain amount of rearrangement

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has taken place. There are fifteen divisions of matter in the work, dealing with such a variety of subjects as Air Pressure and Resistance, Aeroplane Design, Materials, Airscrews, Engines, and so forth; and within their compass Mr. Borlase Matthews has collated a vast amount of practical information. The general reader will set especial value upon the sections devoted to Typical Aeroplanes, Piloting and General Navigation, and the Glossary of Terms, and will appreciate the numerous illustrations distributed through the book. To those who desire to understand the meaning of such words as "Fuselage," "Landing Skid," "Elevator," and the like, we can specially commend the large folding illustration facing page 190, in which the appropriate terms are printed against the various parts of a typical machine.

Whilst Divisions II., III., V. and VI., covering the practical data needed by designers and others who have to come into contact with actual machines in the course of their daily work, will naturally fail to make so *general* an appeal, they nevertheless contain a large amount of matter of considerable interest to the "lay-man." The student of aviation will find Division XII. of great assistance, as it provides a key to the latest literature on the subject.

Amongst the more recently introduced items we notice that parachutes come in for specific treatment. This subject has only recently attracted close attention; and, in view of the increasing importance of these devices, we may look forward to a considerable extension of this section in the next edition. The meteorological section has also been improved and new information appended.

Apart from its all-round excellence of printing, paper, and general "make-up," this useful publication still maintains a high level in its format, and the volume can be confidently recommended to all who study aviation, either for business or for pleasure.

New Mexican Station

WE observe reported in the pages of *Lloyd's List* the establishment of a new Wireless Station on the island of Lobos, off the coast of Tampico, erected mainly for the purpose of affording facilities to the various petroleum companies for communicating with their vessels over great distances at sea. This station is said to be provided with some of the most powerful apparatus available, and is expected to establish communication with the Wireless Stations at Mexico City, Tuxpan, Tampico, Vera Cruz, Progreso, Frontera, Mazatlan, Santa Rosalia, La Paz, Queretaro, Monterrey, Saltillo, Torreon, and by way of Havana with various stations in the United States.

Share Market Report

LONDON, *May 14th*, 1918.

DEALINGS in the shares of the Marconi group have been marked by increased activity during the past month, and prices show a marked firmness. The closing prices as we go to press are as follows: Marconi Ordinary, £3 7s. 6d.; Marconi Preference, £2 13s. 9d.; American Marconi, £1 3s. 3d.; Spanish and General Trust, 9s.; Canadian Marconi, 10s.; Marconi International Marine, £2 12s. 6d.

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Personal Notes

TORPEDOED BELGIANS.

NONCHALANCE.

THE photograph here reproduced shows a party of seamen who have just pulled away from a Belgian ship, which is sinking after being torpedoed by the enemy. Amongst them are Messrs. V. J. N. Rigaux and J. Belthasar, of Société Internationale de Télégraphie sans fil, operators of the unfortunate vessel, the latter of whom is seen fingering the flute. It is refreshing to have evidence of such nonchalance under conditions so trying.

AN ITALIAN LOSS.

We much regret to report the death, following an attack of bronchitis, of Mr. Stanislao Sarti, aged 27, which took place on March 25th last, at Castel San Pietro, Italy, his native town. After taking his degree at the School of Commercial Studies, Bologna, winning first honours, he received appointment as secretary to Senatore Marconi, in London. In 1911 Mr. Sarti transferred to the accounting department of the Rome office, where he was a valued member of the staff, his loss being deeply deplored by superiors and co-workers alike.

STANISLAO SARTI.

CONGRATULATIONS.

We congratulate Captain W. G. Vickers, late superintendent of messengers at the Fenchurch Street office of Marconi's Wireless Telegraph Company, Ltd., whose promotion to commissioned rank we noted last month, on obtaining his captaincy. Captain Vickers hopes to be able to pay a visit home shortly.

CONVALESCENT.

We are glad to learn of the very favourable progress made by Lance-Corporal Frank Saville, after undergoing an operation in the military hospital at Lewisham for the extraction of shrapnel from a wound in the leg, received in action in front of Hangar Wood.

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CORNELIS ZOUTENDYK.

Now in the London Regiment, Lance-Corporal Saville was, before the war, with Marconi's Wireless Telegraph Company, Limited.

MOTOR BOAT ACCIDENT.

A regrettable accident occurred recently at Baltimore, Md., U.S.A., when Mr. C. A. Zoutendyk, operator of the *Westerdyk*, was drowned. Fifteen of the ship's company in a motor boat were returning from shore leave, when she struck a submerged log, heeled over and sank, six lives being lost. Mr. Zoutendyk had been in the employ of Société Internationale de Télégraphie sans fil since 1915. We sincerely sympathise with his bereaved parents.

AWARDS.

The King has been pleased to award the Silver Medal for Gallantry in Saving Life at Sea to Wireless Telegraphist (A.M.II) Bertram Harley Millichamp, in recognition of his services in rescuing two men from an upturned float in the North Sea on May 29th last.

Sergeant A. E. Isles, wireless operator, R.A.F., has been awarded the Military Medal for devotion to duty under heavy fire. Sergeant Isles hails from Battersea.

Hearty congratulations to Sergeant A. Shepherd, of the Messengers' Department, Marconi House, who has been awarded the Military Medal whilst serving with the Oxford and Bucks Light Infantry in France.

Lieutenant Walter Stanworth, R.E., son of Mr. James Stanworth, J.P., of Blackburn, has been awarded the Military Cross for conspicuous gallantry and skill. When in charge of the wireless section from March 22nd to April 2nd he erected forward stations under heavy shell fire. Enlisting in the East Lancashire Regiment in 1915, he later transferred to the Cheshires and was drafted to France, being subsequently gazetted to a commission in the Royal Engineers.

The Distinguished Conduct Medal has been awarded to 11559 Corporal C. J. French, R.F.C., for conspicuous gallantry and devotion to duty on many occasions, when the vicinity of his wireless mast has been heavily shelled, causing damage to the mast and aerial. In every case he has repaired the damage promptly and well, although still under heavy shell fire.

OBITUARY.

Mr. Bridgwater, High Street, Brierley Hill, has received intimation of the loss, by drowning, of his elder son, wireless operator, Arthur Clifford Bridgwater, whilst serving on one of H.M. minesweepers, which struck a mine, and sank. We offer our condolence with his family.

We are sorry to learn that Lance-Corporal Arthur Butler Hutchinson, R.E. (wireless section), son of Mr. and Mrs. R. W. Hutchinson, 3, Harehills Place, Leeds, formerly employed at the Leeds Corporation Electricity Works, has been killed in action, and express sympathy with the bereaved parents.

The *Electrician* reports that a canoe accident at Bedford was responsible for the sad death of Second Lieutenant M. P. McLachlan, R.E., Wireless Signal Corps. Mr. McLachlan served his apprenticeship to electrical engineering with a Bootle firm, and had been some months in the Army.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly.* (3) *Queries should be as clear and concise as possible.* (4) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers.* (5) *The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

P. S. T. (Inverness).—See the "Maintenance of Wireless Telegraph Apparatus," by P. W. Harris, for particulars of how to adjust the disc d scharger. If you are not obtaining a good clear note from the disc of a ½-kw. set it is because the adjustments are wrongly made. The note frequency is dependent upon the speed at which the converter is run, and for this reason any change of note outside the limits of speed variation of the machine is, of course, impossible. It is found in practice that the note given by the ½-kw. disc discharger is high enough to carry well through atmospheric interference, but not so high that it causes the fatigue of the ear, found when working with signals of a frequency in the neighbourhood of a thousand.

WAL (Norfolk).—(1) As we have stated before in these pages, there is no one rank for the wireless operator in the Navy or R.N.V.R. There are various ratings ranging from boy telegraphist to warrant telegraphist, and a number of commissioned officers of various ranks are specially engaged on wireless work. (2) In many cases the men are trained by th authorities themselves, although any qualifications which the applicant may have will count in his favour. On the question of transfer we can only refer you to your commanding officer.

P. O-K. (H.M.S. ——).—(1) The fact that you are a qualified telegraphist in the Royal Navy does not in itself entitle you to the Postmaster-General's First Class Certificate, although we have no doubt whatever that you would obtain one on sitting for the examination. We understand that naval men can sit for this examination by arrangement, and we would suggest that, if you so desire, you apply to your superior officer for permission to do so. (2) Practically no mathematical knowledge is necessary to pass the P.M.G. Examination. If you have a sufficiently good knowledge of wireless theory to understand the principles and working of ordinary ship's wireless apparatus, this should be sufficient for the theoretical side.

H. L. G. (Bridlington).—In our May issue we published an article dealing fully with how to become a wireless engineer. This answers your first question. With regard to the second, if you wish to become a wireless operator on board ship it is necessary for you to undertake a course of training for the Postmaster General's Certificate, without which no person is allowed to operate wireless telegraph apparatus on board ship. The course of training occupies from six to nine months, and therefore as you are now 17, it would be well to start at once. If you leave matters too late you may not complete your training before you reach the age of 18, at which time you will become liable for military service. If, however, you gain your Postmaster-General's Certificate and obtain employment as a wireless operator on board ship you will receive exemption from military service so long as you remain so employed.

SIGS. (Suez).—(1) We do not think this would debar you from acceptance by the Marconi Company if you were otherwise suitable. (2) and (3) The qualifications you mention would certainly be very valuable, particularly in connection with land station work. (4) Your writing is none too good, but you should soon be able to improve it sufficiently to make sure of passing the test.

J. M. (Cuba).—The fatigue of the muscles which you experience is very likely due to your method of holding the key knob. If you hold the key rigidly and with the arm stiff you will soon get tired. Try holding the knob in a different way and in such a manner that the wrist is quite loose and free. (2) Probably you experience difficulty in sending

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the letters H and V and the figure 5 through attempting too high a speed of formation. We would suggest that you practise a long series of dots starting quite slowly and gradually increasing in speed until the formation of three, four or five dots in perfect uniformity becomes as easy as making other signals.

BARTIMEUS (Long Eaton).—(1) No one but an employee of the Marconi Company is entitled to wear the Marconi uniform. With regard to braid, the senior stripes are worn only by men in charge of a Marconi ship installation, and assistant operators, whether they hold a First Class P.M.G. Certificate or not, must wear the single braid. (2) The question of saluting and receiving salutes from members of His Majesty's Forces is readily understood when it is considered that the Marconi operator, not being in the Navy, is neither entitled to a salute nor required to give one when passing members of His Majesty's Forces on shore. If, however, the operator is serving on board ship on which there are naval officers, the position is different and a salute should be given where necessary. The Master of a merchant ship is usually saluted by the operator. (3) This depends entirely upon circumstances. At the present time holders of the First Class Postmaster-General's Certificate go to sea within a very few days of the time they gained the certificate. (4) Yes; but a man is only sent to sea with a second or third class certificate when no first class man is available. Thank you for your good wishes for the success of our magazine. In these times when the difficulties of production are far greater than most of our readers imagine we deeply appreciate these kind remarks.

J. J. R. (Dover).—The formula is quite correct as you give it, but it should be remembered that there is an excess of copper sulphate in the cell and both copper and copper sulphate are present before and after the reaction. Probably this is the reason why the formula is printed in the particular manner quoted.

F. B (Rochdale).—Although we naturally cannot say definitely, we should imagine that as the strain is so slight you would have no difficulty in passing the Company's doctor. Nothing but an actual test by the Company's doctor *at the time you put forward your application* will finally decide this point.

J. S. E. (Carlisle).—We can find no trace of your previous letter. The conditions under which the men are accepted for the branches you mention seem to vary considerably from time to time. You might apply to—(1) Major Handley, R.E., Wireless Training Centre, Worcester; (2) Royal Air Force, Hotel Cecil, Strand, London, W.C.2. We are surprised to hear that the local representatives can give you no information regarding the last branch of the service you mention. If you do not get satisfaction please write to us again.

P. B. H. (Liverpool).—The detector used by the Marconi Company in all its crystal receivers is carborundum. It is true that there are others slightly more sensitive, but this particular crystal was adopted after long experimentation for the following among other reasons:—(1) It is robust and easy of adjustment; (2) It is not put out of action by strong signals, atmospherics or impulses from the adjacent transmitter; (3) Large numbers of crystals can be obtained of uniform sensitiveness; (4) It can be worked with a firm pressure on a steel plate and is thus not shaken out of adjustment by the rolling and vibration on board ship.

It should be remembered that conditions on board ship or in a land station are quite different from those of the laboratory. An operator's first business is to get signals immediately and *keep on getting them*. He has not time to play round for several minutes on end in order to get what he considers the best adjustment. It is useless obtaining a highly sensitive point if all the signals for the previous five minutes have been lost and if the adjustment is liable to go off as a result of the next atmospheric or somebody slamming the cabin door. As a matter of fact, the actual carborundum crystals used by the Marconi Company are selected with great care and are highly sensitive—much more so than those generally obtained by amateurs in peace time.

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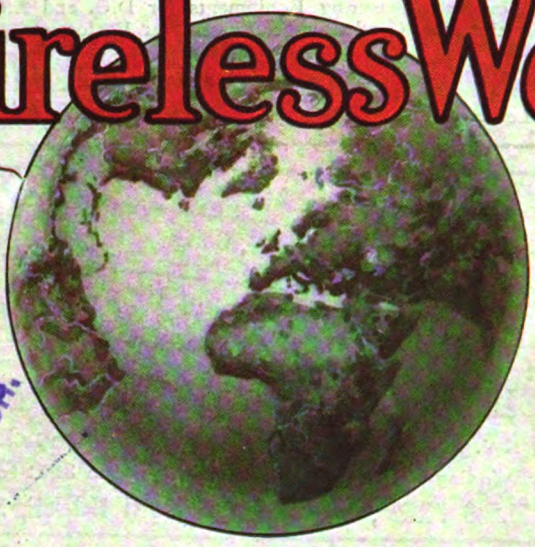
VOL. VI. No. 65. AUGUST · 1918

The Wireless World



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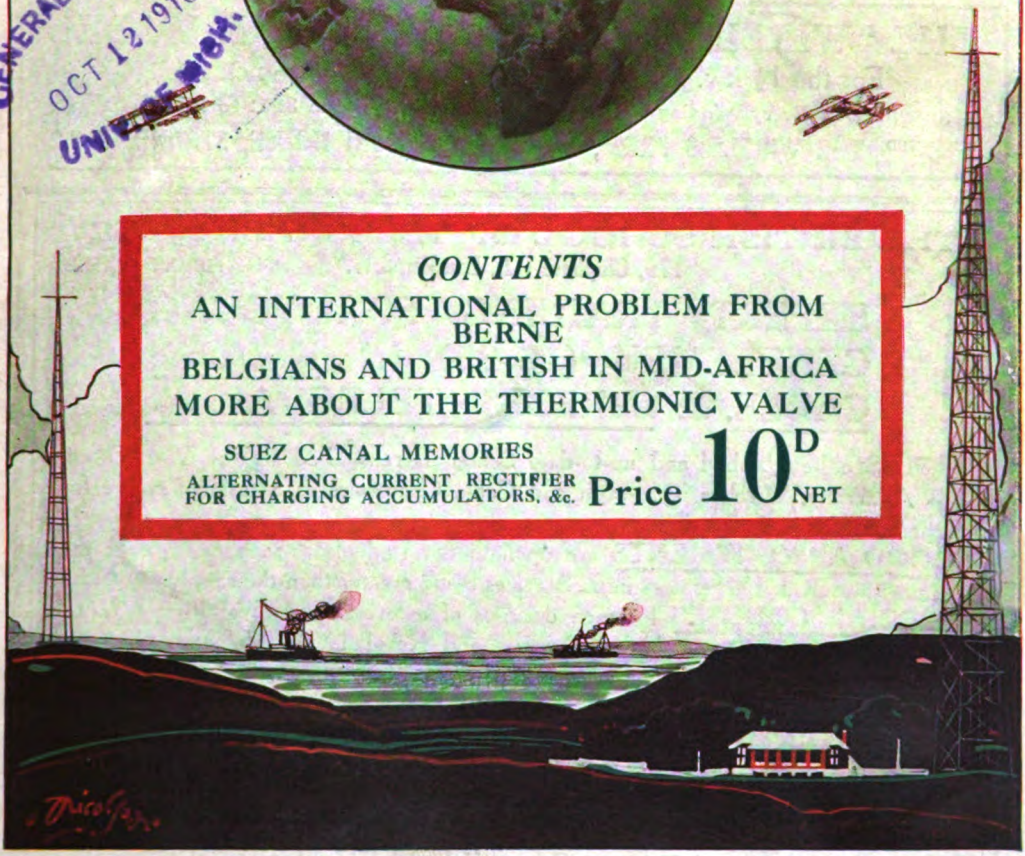

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Registered at the G.P.O. for transmission by Magazine Post to Canada and Newfoundland.

SUBSCRIPTION RATES.—United Kingdom and British Empire (outside North America), 12s. per annum, post free; United States, Canada, and Newfoundland, $3.00 per annum, post free; and Europe, frs. 15 per annum, post free.

Single copies, 10d. each, or post free 1s. 1d.

Articles submitted for acceptance by the Editor (which will be paid for on publication) should be addressed to Marconi House, Strand, London, W.C. *No responsibility can be taken for MSS. or Photographs sent without stamps to defray cost of return postage.*

Telegraphic Address: "Expanse, Estrand, London." Tel. No.: City 8710 (1 lines).

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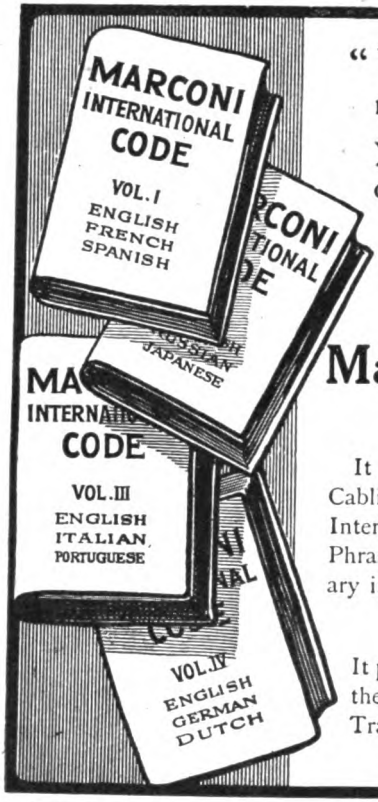

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The
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·WORLD·

Volume VI. No. 65. AUGUST, 1918.

Belgians and British in Mid-Africa

The Doings of Four Wireless Men on Lake Tanganyika

By H. J. B. WARD, B.A.

WHERE is Lake Tanganyika? And what is included in the Belgian Congo? I suppose that some of us will be obliged to answer two such questions with "somewhere in Africa," and that we should find such a response to constitute the "be-all and end-all" of our information on the subject. It is here that war—like travel in normal times—steps into the breach.

Possibly the four young wireless men, who towards the close of 1915 received orders to proceed to Tanganyika, owned but little more detailed information than the accurate but somewhat vague statement set forth above. One of them, interested in the records of Great British Explorers, knew that its discovery was due to those famous nineteenth century pioneers of ours, Speke and Burton, and that its mountain-fringed waters and lovely scenery formed the scene of some of the labours of Livingstone and Stanley; but with regard to his comrades I cannot say. I can remember, not so long ago, an occasion when a wireless engineer received instructions to proceed to some little known islands much nearer home. He came to tell me of his forthcoming journey, confessed that he scarcely knew where they lay, and sought eagerly for information. To such a purpose, however, did he bestir himself that he knew the subject as well as it could be mastered from books long before he started; and, when he came back after some months of labour crowned with success, he was able to contribute to the pages of THE WIRELESS WORLD as

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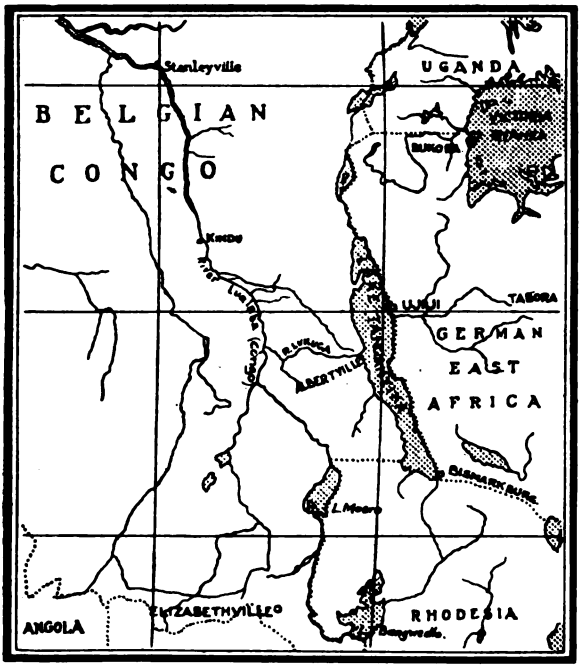
interesting and informative a typographical article as any magazine readers could wish for.

As a matter of fact, the lake to which our friends were ordered forms the eastern boundary of the Belgian Congo and the western boundary of German East Africa. Its southern end is fringed by the northern borders of Rhodesia, whilst immediately to its own northern extremity lies the Uganda Protectorate. It will be seen at once, therefore, that this remote, attenuated strip of deep water—420 miles long, and 15 to 80 wide—constitutes, in a very true sense, the heart of Africa.

So soon as hostilities were initiated against the Central Powers, Britannia stretched forth her trident and cut off from all outside aid the seaboard of German East Africa, that wedge which our insidious foe had been allowed to drive in between Uganda and Rhodesia. Tanganyika is a real inland sea, and the British Admiralty determined that the enemy flag should be deposed from its flaunting superiority thereon. Commander Spicer-Simson was placed at the head of a small Expeditionary Force, and provided with two well-armed motor-boats, which were conveyed first to Cape-town and thence by rail over a land journey of 2,000 miles, *via* Bulawayo and Livingstone to Elizabethville in the Belgian Congo. Radiotelegraphy constitutes an inseparable adjunct of the British Navy, and four young wireless men, Messrs. Boileau, Warren, Moore and Williams, were attached to the force. The illustrations of this article are reproduced from photographs taken by Mr. Boileau, and I hope that this brief epitome of their travels and labours will serve the purpose of indicating the nature of the country which formed the scene of their labours, and the indomitable spirit of the men who overcame difficulties which might well have been deemed insuperable.



After leaving Elizabethville, our adventurers had to haul their craft for 150 miles over atrocious roads and across a country varying in altitude from 2,000 to 6,000 ft. This accomplished, a further journey on trucks over a short section of railway brought them to the Lualaba River, the name given to this important section of the Congo, and down this stream the vessels were floated for 400 miles, proceeding now by their own power and now on lighters. Finally, these wandering units of the British Fleet reached their destination and emerged upon Lake Tanganyika at the Belgian port of Lukuga, about halfway up the western shore of the lake.

At this little port of Lukuga was enacted, in the early days of the war, the opening act of hostility on the part of our Teutonic foe. The German steamer *Hedwig von Wiessmann* inaugurated offensive operations by shelling the Belgian coast in August, 1914. The Berlin Act of the 26th February, 1885, had neutralised the Belgian Congo, and, in its second Article, had gone so far as to provide that, in case of war being waged by the ruling Government in another part of the world,

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the Congo territory should be placed under a *régime* of neutrality. Belgium herself had, on the outbreak of the European war, advised France and England on 7th August of her intention to carry out this neutrality provision of the Berlin Act. The almost immediate launching of hostilities, therefore, in this quarter of the globe on the part of Germany, forms a striking illustration of the uselessness of any international pact to which that unscrupulous empire may be a party.

In Africa, as elsewhere, the Huns had long organised for war, not only drilling thousands of stalwart native troops, but entering into compacts with the chiefs of the various warlike tribes to co-operate with the trained forces, and to offset by their swarms of savage levies the lack of cavalry scouts for which the presence of the tsetse fly was responsible. Guns of all calibres and military stores in large quantities had been accumulated. The German armed vessels ensured them absolute supremacy on Tanganyika Lake, and from Ujiji, the lake terminus of the railway from Dar-es-Salaam, the transport of materials for the German offensive against the Belgian and British Colonies went on apace, until the arrival of the British vessels changed the situation.

The speed with which this revolution in the state of affairs was effected may be judged from the fact that the *Kingani*, an important unit of the Teutonic Fleet, surrendered on December 26th, 1915, after having been disabled in a thrilling fight. She was repaired and added to the British flotilla, playing a useful part in subsequent operations. The *Hedwig von Wiessmann*, to which I have referred above, was the next victim, being destroyed in action about six weeks later. The engagement with this second enemy vessel of war was described in a letter home (published by the *Times*), from which readers may be interested to peruse the following extract :

STEAMERS BY THE LAKE.

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TRANSPORT THROUGH THE FOREST.

" I was on the *Mimi* (one of the motor-boats). After running for an hour and a half to two hours the German was sighted and did the usual thing—namely, turned and ran. . . . It did not take us long to catch her, as these motor-boats of ours are pretty fast, and we opened fire. . . . The first hit registered went bang through the boiler of the German, who from then on had a bad time of it. . . . Within half an hour she turned slightly, plainly out of control, and soon afterwards began to sink by the head. She finished up by putting her stern high in the air and diving straight to the bottom. As soon as she had disappeared we made straight for the wreckage and saved every one—namely, twelve Germans and ten niggers. This was slightly different from what the Germans did when the *Good Hope* and *Monmouth* sank. There were fourteen Germans on board, but two were killed in the engine-room and went down with the ship. Out of the twelve, nine were *Koenigsberg* men. What a haul! Without telling you the strength of either side, I can assure you that we are absolutely ' Cock of the Lake ' now."

The third and last war steamer maintained by the enemy on the lake, the *Graf von Gotzen*, was announced as destroyed by the Belgians in July, 1916. Our brave Allies succeeded in catching and putting her out of action just as she was in the act of disembarking troops for a surprise expedition.

The country through which our wireless friends and their little party had to make their toilsome way, though inhabited by a vast number of native races in a low state of civilisation (their number has been estimated at fifteen millions), is largely undeveloped and " in the raw." The difficulties involved during that 150 miles of haulage were simply indescribable. The Commander of the Expedition narrates how on some occasions they were obliged to sacrifice not only their washing but their drinking water in order that the boilers of the traction engines should be supplied with the necessary material for progress. He comments upon the self-sacrifice thus shown by his companions in the following terms :

" Only those who have had to work without shade in the thick dust raised by engines under a tropical sun, when you have nothing to wash in and nothing to

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drink, can realise what determination is required to keep up the necessary energy for overcoming the heart-breaking difficulties of the route. It was, in the opinion of all competent judges, sheer madness to attempt to take traction engines over it by themselves, and still more so to try and tow boats by this means or by any other."

Nothing succeeds like success, and the native African judges by results. Apart from material loss inflicted upon the enemy, the success of this naval expedition wonderfully enhanced British prestige amongst the natives, not only in the neighbourhood of the lake but in the northern districts of Rhodesia and in adjacent German territory.

In districts such as this, wireless possesses advantages over all other means of communication, to a far larger degree even than in more favoured lands. This fact was brought out very clearly in the memorable despatch of General Smuts, which summarised his campaign as a whole.* The Belgians, in the course of 1916, linked the Victoria Nyanza with Lake Tanganyika by means of mobile wireless sections, and developed its utilisation throughout their forces in a way which had never been exemplified before in these parts. They claim that the little stations they utilised, though capable of being carried by a despatch rider upon his bicycle, can develop a power of 500 watts, and possess a range of nearly one hundred miles. The announcement of the successful sinking of the *Hedwig von Wiessmann* was reported from Albertville, a town on the Belgian coast of Lake Tanganyika, and was published in the *Times* within a wonderfully short interval after the action had been consummated.

In the course of the expedition it was necessary for the ensurance of success that our Belgian Allies should labour harmoniously shoulder-to-shoulder with our own men. It is a matter of real gratification to know that this co-ordination was characterised by the most striking cordiality throughout, and that British and Belgians alike speak in terms of high appreciation concerning the efforts and fraternal feelings displayed by each other.

NATIVE BEARERS WITH THE EXPEDITION.

* See the article entitled "Human Interest in an Official Despatch" in THE WIRELESS WORLD, page 916 of Vol. IV.

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PERSONALITIES IN THE WIRELESS WORLD

Photo] [*Elliott & Fry.*

MR. RAYMOND D. BANGAY

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THE subject of our notice this month is Mr. Raymond D. Bangay, whose connection with wireless telegraphy has been intimate since quite its early days. It is typical of this, the latest arrival amongst applied sciences, that its prominent votaries should be comparatively young in years. Mr. Bangay, son of Dr. R. Bangay, M.D., first saw the light in 1883 in the municipal borough of Lyme Regis, an old Dorsetshire town mentioned in Domesday Book, which played an honourable part in the earlier history of our country. Epsom College was the scene of his schoolboy days, and, after leaving this establishment, he proceeded to specialise in scientific subjects at the Finsbury Technical College, an institution whose name is closely linked with a number of Britain's most eminent men of science. Mr. Bangay joined the Marconi Company's staff five years after the parent company had been incorporated under the title of "The Wireless Telegraph and Signal Company, Limited"; 1902, the date of his initial connection with the Company, witnessed considerable progress in wireless transatlantic work. Mr. Bangay next crossed the Atlantic and spent five years in America, actively engaged in radiotelegraphic practice. He did not confine his attention to any particular branch, but during the period of his sojourn on the other side made full use of his opportunities, with the result that he then acquired that clear conception of basic principles and practice which he afterwards crystallized, for the benefit of numerous students, in his *Elementary Principles of Wireless Telegraphy*. This, his first essay in book production, originally appeared in 1914, and—constantly improved in successive editions—has ever since "held the field" as one of the best manuals of instruction for students starting on a wireless career. In 1910, during the American period of Mr. Bangay's service, he started to specialise in portable apparatus, a branch of radiotelegraphic activity which has engaged his closest attention ever since. In 1914 he was appointed Chief of the Field Station Department in the service of Marconi's Wireless Telegraph Company, Limited, a capacity in which the specialisation above referred to has stood him in good stead. This responsible post he still continues to occupy, and it has afforded him many opportunities to render extremely valuable service in his country's cause, opportunities of which he has availed himself with patriotic zeal.

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Mechanical Analogies to Inductively Coupled Electric Circuits

By H. M. BROWNING

II.

In Article I. (see July issue of Wireless World) the method of using interacting pendulums to demonstrate the action of oscillations in electric circuits was described. Photographs of the apparatus used and experimental results for certain cases were given. In this article the results of theory are set out, and it will be found how closely they agree with experiment. Although the mechanical cases are not perfectly analogous to the electrical cases, yet when the separate pendulums are equal, the ratio of the frequencies of the coupled vibrations is identical with that of the electrical case for equal circuits.

The initial condition in the electrical case is probably an electric displacement in one circuit; thus, if the mechanical vibration is started by a displacement of one pendulum bob there is almost an exact visual representation of the oscillations occurring in the electrically coupled circuits.

Theory.

The equation for simple harmonic motion may be written:

$$A\frac{d^2y}{dt^2}+Aay=o \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where A is inertia, Aa spring factor, y displacement and $\frac{d^2y}{dt^2}$ acceleration.

When the vibrations are mechanical, and are due to the oscillations under gravity of a pendulum made by a light cord of length l and a heavy bob of mass P, for small amplitude of swing, equation (1) becomes:

$$P\frac{d^2y}{dt^2}+P\frac{g}{l}y=o \quad . \quad . \quad . \quad . \quad . \quad (2)$$

When the vibrations are electrical, and are caused by the discharge of a condenser of capacity R, through a self-induction L, the equation may be written:

$$L\frac{d^2y}{dt^2}+\frac{y}{R}=o \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In this case y is the charge on the condenser. By comparison of (3) with (1) and (2), it is seen that the self-induction can be likened to inertia and the capacity to the reciprocal of the spring factor if a charge is an electrical displacement.

When a second circuit of capacity S and self-induction N is brought very near to the first and thus made to influence it by electromagnetic induction, the circuits are then said to be coupled. In this state the phenomena in each circuit depend partly on those in the other. The single factor that expresses this dependence or cross-connection between the variables is M, the coefficient of mutual induction. It is of the same physical nature as the two self-inductions of the separate circuits, thus it also functions as an inertia.

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Then as z is the quantity or electric displacement in the second circuit, the equations of motion for the two circuits may be written :

$$L\frac{d^2y}{dt^2}+\frac{y}{R}=M\frac{d^2z}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$N\frac{d^2z}{dt^2}+\frac{z}{S}=M\frac{d^2y}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The coefficient of coupling γ is given by

$$\gamma^2=\frac{M^2}{L.N}$$

So far no exact mechanical analogy has been found in which a second pendulum with bob of mass Q and length ηl can be coupled with the first by means of a connecting mass J, so that the equations of motion may be written :

$$P\frac{d^2y}{dt^2}+P\frac{g}{l}y=J\frac{d^2z}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and

$$Q\frac{d^2z}{dt^2}+Q\frac{g}{\eta l}z=J\frac{d^2y}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

But, by the arrangements described in Article I., equations of motion are obtained of the form :

$$B\frac{d^2y}{dt^2}+C\frac{g}{l}y=D\frac{d^2z}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and

$$E\frac{d^2z}{dt^2}+F\frac{g}{\eta l}z=G\frac{d^2y}{dt^2} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

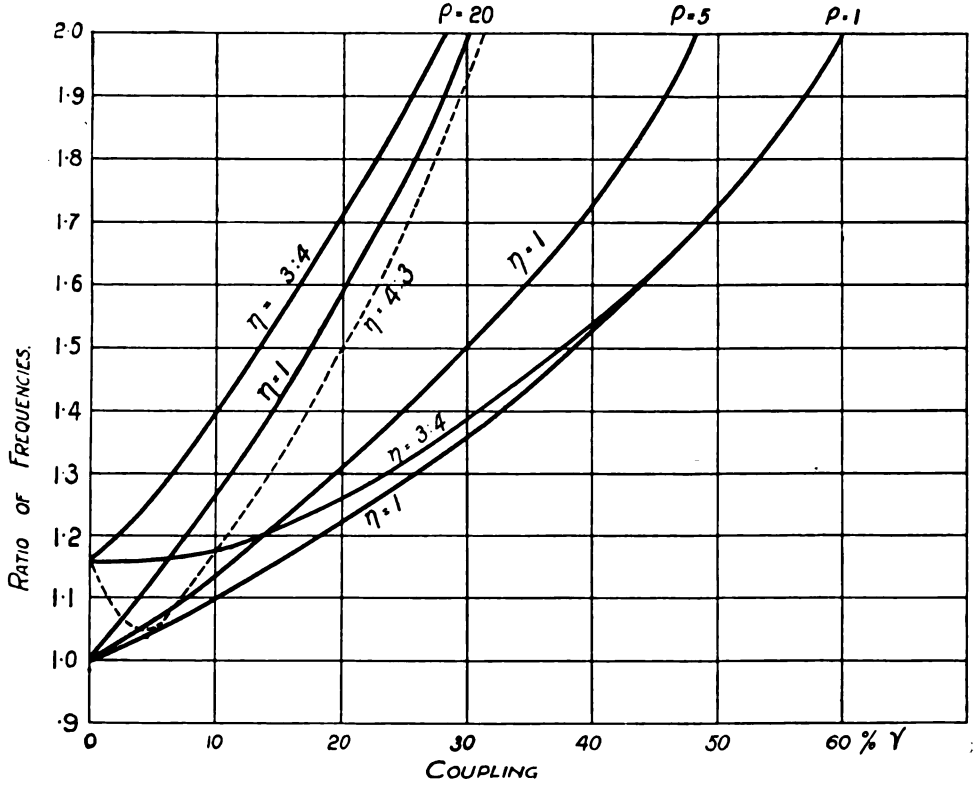

FIG. 9.—FREQUENCY RATIO AND COUPLING.

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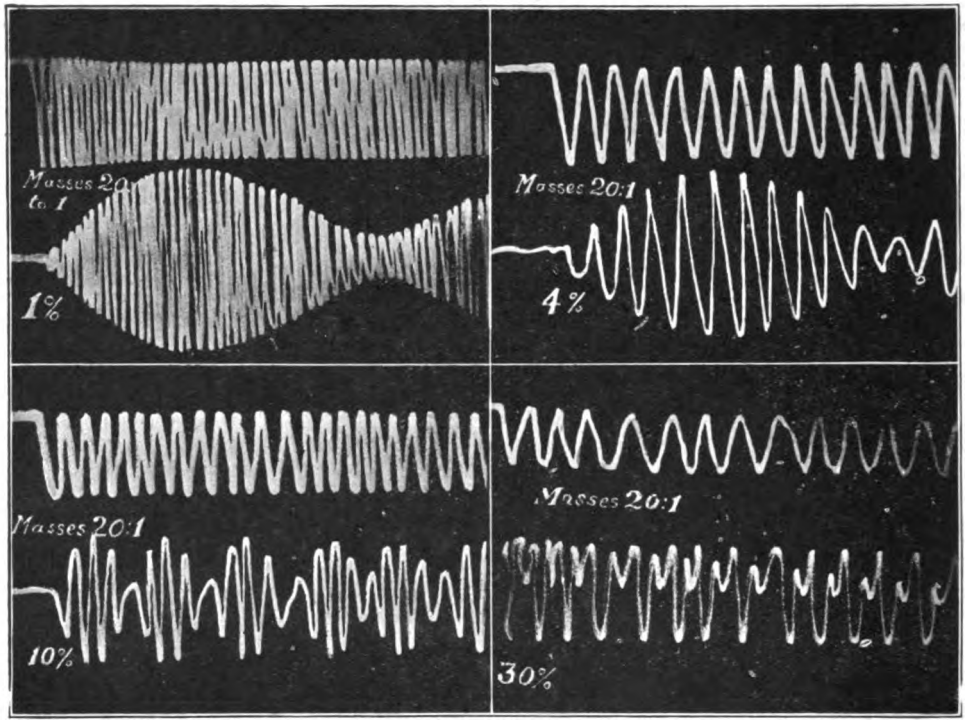

FIG. 10.—DOUBLE TRACES, BOB MASSES 20 : 1.

where B, C, D, E, F, and G are functions of the masses of the bobs P and Q, and the ratio of the lengths of the pendulum suspensions, bridle droop, etc.

In this case the coupling is given by

$$\gamma^2 = \frac{D.G}{B.E}$$

Thus coupled pendulums may be used as analogies to electric circuits, the masses representing the self-inductions, the lengths being proportional to the capacities. Then if two pendulums have equal lengths and masses, they are like two similar inductively coupled circuits. If either the masses or the lengths are unequal, or both masses and lengths unequal, the system is like two electric circuits with differing capacities or self-inductions or both. The case of a pendulum with a heavy bob on a short suspension coupled with one having a light bob on a long suspension is analogous to the case of a wireless transmitter with a large self-induction and small capacity, and a receiver with small self-induction and large capacity.

Let m and n be proportional to the frequencies of vibrations of the separate systems, whether mechanical or electrical, and let p and q bear the same relation to the frequencies of the vibrations superposed on one another with which each circuit or pendulum oscillates when the two are coupled. Then in the electrical case—

$$p > m \gtrless n > q$$

and in the case of the double-cord pendulum, when $m = n$

$$p = m, \text{ and } n > q$$

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but the ratio p/q in this case and for coupled equal electric circuits is identical, and given by $\sqrt{\frac{1-\gamma}{1+\gamma}}$, where in each case γ denotes the coupling.

Fig. 9 shows curves between couplings and ratio of frequencies for the double-cord pendulum. In these curves ρ denotes ratio of masses of bobs and η the ratio of lengths of suspensions.

With the separate frequencies—*i.e.*, lengths of pendulums—equal and a given coupling, it may be noted that the greater the inequality of the masses, the greater is the inequality of the resulting superposed vibrations of the coupled systems.

When the coupling vanishes, the frequencies of the separate vibrations are, of course, undisturbed. Thus for equal lengths, but for any ratio of masses we have for $\gamma=o$, $p:q$ equals unity. But for different separate frequencies—*i.e.*, η not equal to unity—we have for $\gamma=o$, $p:q$ greater than unity. However, for large couplings the effect of unequal separate frequencies gradually disappears. This is also the case for pendulums which have masses and separate lengths unequal, but the large mass on the long length. If the long pendulum has the light mass on it, and the short pendulum the heavy mass, with coupling zero, the ratio of the frequencies is naturally that which applies to the separate pendulums. But in this case, when the coupling is increased, the value of p/q at first diminishes, reaches a minimum and then increases. The dotted curve marked $\eta=4/3$, $\rho=20$, in the frequency-coupling diagram shows this special case. It was first obtained theoretically and afterwards experimentally confirmed.

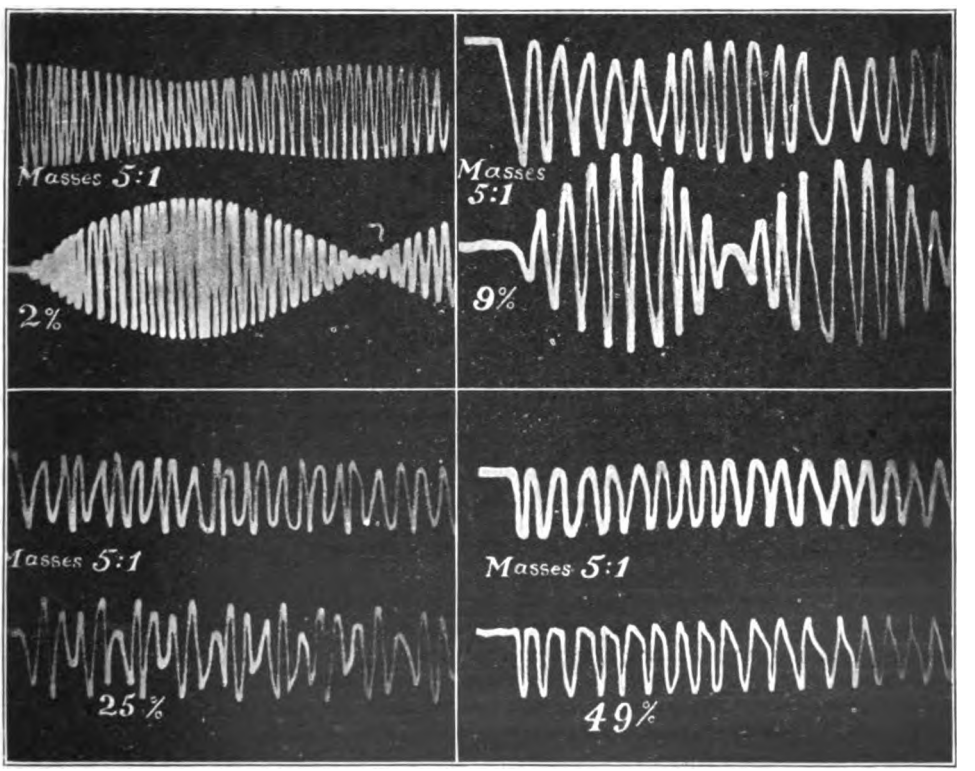

FIG. 11.—DOUBLE TRACES, BOB MASSES 5 : 1.

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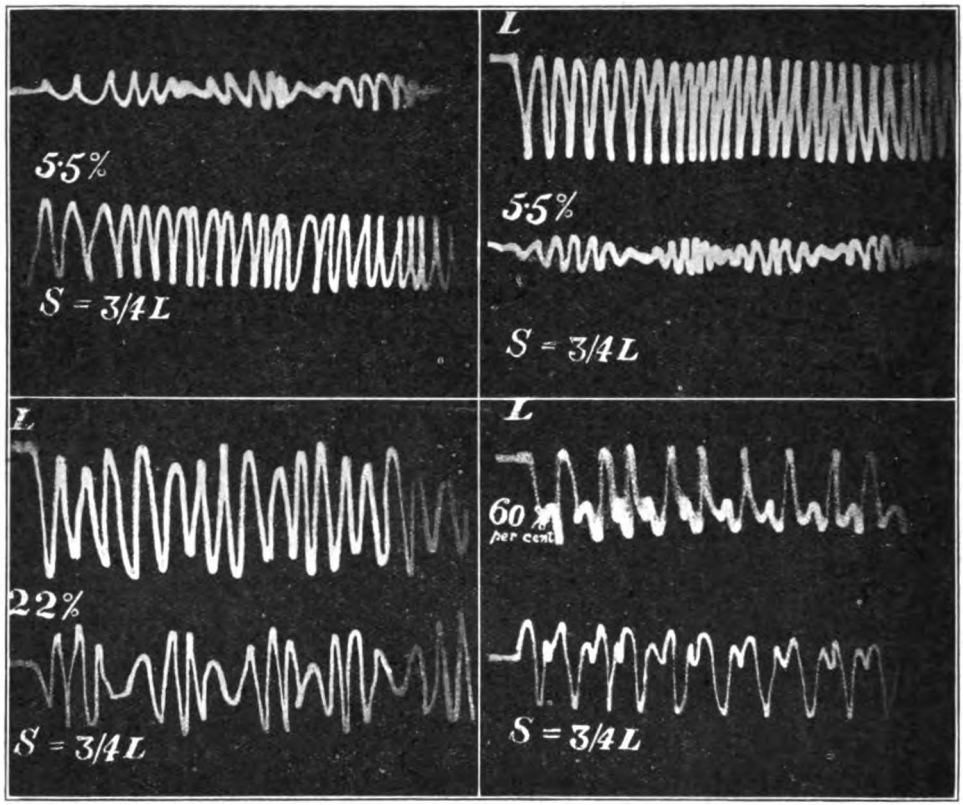

FIG. 12.—DOUBLE TRACES, LENGTHS 3 : 4.

EXPERIMENTS WITH MASSES OF BOBS OR LENGTHS OF PENDULUMS UNEQUAL.

All the experiments for unequal lengths or masses were done on the double-cord pendulum.

Masses 20 : 1.—The bobs were of the order 1,000 gms. and 50 gms. respectively. Photographs (1)–(4) of Fig. 10 represent double sand traces simultaneously obtained when the masses of the bobs were as 20 : 1. The couplings vary from 1 per cent. in the first to a little over 30 per cent. in the last, and are shown as percentages on the figures.

Photographs (1) to (3) were obtained by drawing the heavy bob aside horizontally, the light bob being allowed to hang at rest in its more or less displaced position. This is almost like charging the circuit with larger inductance, while the other circuit is given a slight charge.

In the three photographs shown the initial displacement of the light bob is almost negligible compared with that of the heavy bob, so it approximates to the ordinary method of obtaining coupled electrical discharge, where one circuit only is charged and then allowed to influence the other. Photo (4) was taken with the light bob held undisplaced and the heavy one drawn aside.

Comparing these photographs with Fig. 7 of the previous article, a marked contrast is seen in the behaviour of the upper curve. Because of the inequality of masses in the present case, while the resultant vibrations of the light bob (shown

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in the lower curve) wax and wane in amplitude, those of the heavy bob scarcely fluctuate; thus showing that with masses 20 : 1 the limiting case of forced vibrations has been nearly reached, since the reaction of the driven on the driver appears negligible. The frequencies are, however, still appreciably affected. As in the case for equal masses, increase of coupling causes increase in the inequality of the frequencies of the superposed vibrations, but in this case for coupling 30 per cent. the ratio of frequencies is 2 : 1; whereas for that of equal masses and lengths a coupling of 60 per cent. was necessary to give this frequency ratio.

Masses 5 : 1.—The masses of the bobs used in these experiments were of the order 600 gms. and 120 gms. respectively. Fig. 11 shows double traces obtained with this arrangement. This case is seen to be intermediate to those with masses of bobs equal and masses as 20 : 1. The beat effect left by the lighter bob is seen plainly in the lower trace, while those of the heavy bob show distinct but much slighter fluctuations. Further, a coupling of 49 per cent. is necessary for frequency ratio of the superposed vibrations to be 2 : 1.

Lengths 3 : 4.—The masses of the bobs in this case were equal, but the lengths of suspensions as 3 : 4. The lower trace on each figure is made by the shorter pendulum. Fig. 12 shows four photographs of the double traces. The first of these was taken when the shorter bob was drawn aside, the others with the long one drawn aside, and the other bob at rest in its more or less displaced position or held undisplaced. The couplings are marked on the photographs.

Photos (1) and (2) show that it does not make any difference whether the long or short bob is drawn aside.

It is also seen that the difference in lengths makes the action of the driver on the driven very small for small couplings, so in electric circuits, if one circuit has a different capacity from the other, while the self-inductions are the same, the response of the second to the first is not appreciable. If, however, the coupling is great, the effect of inequality of length disappears, and photograph (4) is seen to be almost identical with photo (6), Fig. 7, of Article I., in which latter case the lengths were equal.

This second article has given a brief general theory, and dealt with the special cases of vibrations with either the masses of the pendulum bobs or the lengths of the suspensions unequal, which cases are somewhat analogous to coupled electric circuits with inductances or capacities unlike.

In a final article it is hoped to deal with the general case for both masses and lengths unequal, and to describe experiments showing why a wireless receiver has to be tuned to obtain waves of a certain frequency sent out by a transmitter.

An Interesting Anecdote

A REVERSION to the inductive method of wireless telegraphy through the earth is indicated in a little incident narrated by W. J. M. Locke, M.C., in the course of a war lecture recently delivered at Melbourne. It appears that during the attack on the Hindenburg Line east of Bullecourt, a party of Australians found their flank turned by a sudden enemy onslaught. One solitary Australian soldier was seated in an enemy dug-out which had been captured from the Germans earlier in the day, and for some considerable time was completely encircled by the German forces. Being at the transmitting end of an underground earth wireless installation, he was able to send to headquarters a detailed account through that medium of all that was going on. In consequence, the Australian artillery managed to find the range of the enemy, whose counter-attack was ultimately dispersed. The gallant signaller was relieved from his perilous isolation, and some little time afterwards was decorated for his bravery by the Distinguished Conduct Medal.

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Digest of Wireless Literature

Oscillation Valve Circuits.

The purpose of this paper is to explain the general principles upon which depend the uses of the valve for generating electrical oscillations and for amplifying externally impressed oscillations by "regenerative action," and to discuss in detail the action in certain circuits. It is shown that the criterion for the generation of an oscillation and for the measure of its intensity is directly determinable from the constants of the circuit and from the characteristics of the audion.

At the present moment the different connections in which three-electrode valves are used for generating or receiving are very numerous, and the author classifies these into groups, so that any particular connection may be referred to its corresponding group. This grouping has the further advantage that new connections are suggested by the systematic manner in which one group of connections is evolved from another.

The first set of connections considered refers to simple oscillation circuits connected inductively or electrostatically to the valve circuit. The second set refers to connections in which coupled circuits are used with the valves, the couplings between the individual circuits and between the circuits and the valve circuit being tight or loose and effected by electromagnetic or electrostatic means. Each type of connection is again sub-divided into sub-sections by the interchanging of the connections to the filament, grid, and plate.

In each case formulæ are worked out determining the conditions under which the audion tends to maintain impressed oscillations and the conditions under which the impressed energy will be absorbed. It is found that with certain arrangements the audion will have regenerative action only over a very short range in frequency, absorbing energy from oscillations at all other frequencies. This result affords a means of reducing interference especially from unsustained oscillations such as are caused by strays.

If I_p is the plate current and E_p and E_g the plate and grid voltages respectively, g the conductance from the grid to the plate and g_p the quotient of a variation in the plate current by the corresponding variation in the plate potential, then $I_p = E_g g - E_p g_p$ is usually very small compared to g, we may write approximately $I_p = E_g g$. If the plate is positive with respect to the filament there will be an output P from the audion given by $P = E_p I_p$. It therefore follows that $g = P/E_g . E_p$. The smaller this quotient the more easily will the audion oscillate, and if the quotient is greater than the value of g obtainable from the audion no free oscillation will occur, but externally impressed oscillations may be greatly multiplied. This is known as "regenerative action." If an impressed oscillation causes the grid and plate to be of the same polarity its energy will be absorbed and the audion may thus be used to diminish undesirable oscillations. The form of the quotient giving the value of g is symmetrical in E_g and E_p, which shows that the plate and grid potentials are interchangeable.

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The value of g for given adjustments of the audion depends on E_g, being smaller for higher values of E_g. Hence if the highest possible value of E_g is desired for a given energy of oscillation (as in radio receiving), E_g should be made small relative to E_p.

The calculation of the quantity g and the frequency of the oscillations obtainable by means of various connections of the audion is made according to two methods. In the first, all currents are assumed to be in phase with one another, and the power loss in each branch is obtained by squaring the current and multiplying it by the resistance of that branch. In this manner the value of P is obtained. If, however, the resistances are high, or the coupling between circuits very loose, or if high accuracy is desired, both the resistances and reactances of the various branches must be considered together. This is carried out in the second method of calculation by the use of complex notation. One particular connection of the audion is claimed to be novel. This is based on a utilisation of the fact that there are two frequencies of oscillation when the audion is used in connection with coupled circuits. If the audion be allowed to oscillate at one of these natural frequencies while the other is brought into coincidence with that of the signal to be received, the audion may be brought to the verge of changing from one frequency to the other, and amplification is then possible. This is called the " self-heterodyne " principle.

Another set of novel connections is deduced from circuits already in use by interchanging the plate, filament and grid with the filament, grid and plate respectively.

While the author does not claim to have included all possible oscillating audion circuits he hopes that the methods given will lead to the discovery of new circuits of importance. Two appendices are given. In the first a graphical method is given for determining the effective mutual conductance g under working conditions, and a " derived characteristic " representing the conditions during an oscillation is obtained from the characteristic curves of the audion, enabling the relations to be obtained between the coil inductances, or between the condenser capacities, in the plate and grid circuits that will result in the greatest power output from the audion when acting as a generator. The second appendix contains a mathematical proof of the fact that the grid and plate of an audion may always be interchanged.—(L. A. Hazeltine, *Institute of Radio Engineers Proceedings*, April, 1918.)

A RADIO PHENOMENON.

Smoke passing through an aerial has, according to a writer in the *Wireless Age*, the power to transmit heavy deposits of static. Ship operators have perhaps been aware of this fact for a long time, but it is probably news to many land amateurs. " The phenomenon was first called to my attention," says the correspondent, " at Fort Leavenworth, where the college station ' WUV ' experienced considerable trouble from a mysterious source. Major J. O. Mauborgne, who took charge of the Signal School there last autumn, quickly traced the trouble to its source and proved conclusively that the frequent violent surges of static which would appear and suddenly disappear on nights which were unusually free from atmospheric disturbances were caused by smoke clouds from passing trains. He expressed a determination at the time to write a paper on his investigations of the phenomenon, but was called for service in the radio laboratories in Washington and has no doubt been too busy to give the matter further thought.

" The writer, whose aerial was also exposed to smoke clouds from passing trains, made frequent tests up until the time the stations were ordered closed, and a passing train never failed to disturb the station when the wind was favourable for passing the smoke through the aerial. The charge of static would ' spill ' the audion and made a fine display in the variable condenser which was used in series with the antenna to shorten the wavelength."

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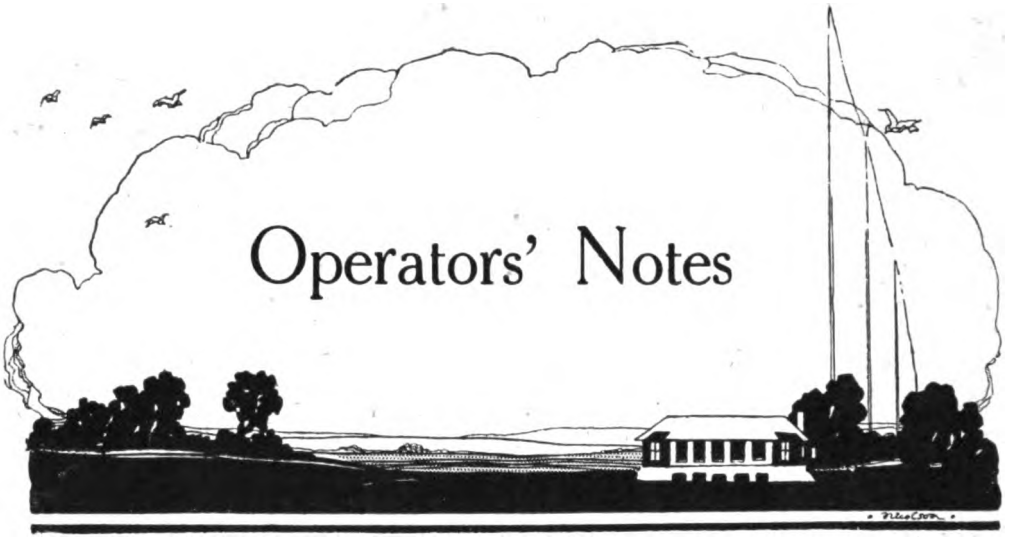

Wires and Wiring (I.)

By ROTAREPO

ALTHOUGH "wireless" is the generally accepted term for radiotelegraphy, it is somewhat of a misnomer, inasmuch as both wires and wiring play a very important part in the construction of a station. It thus becomes necessary to ensure that all joints and connections are perfect, and that wires of the correct grade and gauge are selected.

Junior operators will do well to bear in mind that, although their stations are usually wired ready for use by the Company's engineer, the need for repairs and alterations constantly arises, and they should, therefore, make themselves familiar with the various methods employed in wiring up their sets. From time to time juniors get an opportunity of valuable practical experience, being sent abroad to assist an engineer in fitting a ship's installation prior to taking charge of the set. Needless to say, the man chosen for such a pleasant and instructive task must have some knowledge of the use of tools and simple wiring. All operators keen on their profession should therefore take every opportunity to become good practical mechanics.

The following is a partial list of the most commonly used wires and their particular usages in the construction of a standard ship set. The first figure denotes the number of component strands forming the cable, and the second the gauge of each individual strand.

7/16 tinned copper coated with rubber and insulating tape, the whole being lead sheathed, is used for primary D.C. and A.C. circuits. Sometimes the lead sheathing is earthed.

1/18 same as above is generally used for field and guard-lamp circuits.

3/22 ditto for the same purpose is sometimes used.

7/18 tinned copper I.R.V.B. (insulating tape, rubber, vulcanised and braided) or 7/20 ditto are used for primary circuits of coil sets, earth leads, etc.

Plug connections to aerial are generally made with 30 amp. dynamo flex, insulated with rubber and cotton or silk.

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70/40 copper twin flex, triple cotton, rubber and silk is the wire used for receiving leads.

Bell wire is generally made of No. 22 tinned copper, and is insulated in various arrangements of cotton and rubber or cotton, rubber and silk.

Aerials are formed of a number of various materials, but generally uninsulated, the most common of which is 49/28 silicon bronze.

No. 10 bare annealed copper is employed when making connections of secondary of coil or transformer.

Ordinary switchboard fuse consists of No. 18 lead wire.

Irregular and untidy wiring is most unsightly, besides being the source of numerous "faults." The following general hints should therefore prove of value to all those who are not thoroughly acquainted with this branch of their profession.

Where wires have to be laid up a wall see that they run perpendicularly and parallel to each other. When porcelain cleats are used the wires should be stretched tight before finally screwing up the top piece. If staples are used, take care not to drive them too far home or the insulation will suffer, or even the wire itself get cut. Do not make sharp bends, round them off into sweeping curves. Whenever wiring avoid crossing leads, but should this become necessary make the crossing as near at right angles as possible. Avoid laying wires on top of operating table, or in an exposed position where they are liable to be subjected to heavy knocks or accidental kicks.

In concealed wiring, such as under the table, it is advisable to run the leads from point to point in the shortest possible direction compatible with the foregoing advice.

When joining two single strand wires the joint which gives the most satisfactory electrical connection for the minimum amount of labour expended is formed as follows: Strip and clean, in the case of insulated wire, about two inches of each of the two ends to be joined. Lay these bared portions side by side and tightly bind each one round the other, care being taken that each turn lies close up to the previous one. Complete the joint with solder, and re-cover with insulating tape.

Flex may be treated in a similar manner, except that the joint should be made longer and the turns laid more in the direction of length of wire rather than at right angles to it. If it is desired to retain the flexibility of the joint solder must be used sparingly in the centre only, the turns being held in place by "seizings" (bindings) of thread.

Three-strand wire can also be joined in the same manner, though the component strands should be untwisted, and cleaned individually, for about two-thirds of the whole length bared prior to commencing the joint, in order that each strand may lie in actual contact with the main wire round which it is bound. Perhaps this may be more clearly expressed by saying that there should only be one "layer" of windings round each main wire, and not three, as would be the case if the strands remained untwisted.

If the joint is likely to be subjected to any mechanical strain it should be made in a manner similar to that explained for seven-strand wires.

The joining of seven-strand wires has previously been fully explained by Mr. Ward in the April number under the heading "Repairing an Aerial." However, it will no doubt be of use to point out that the two main wires after the first operation should be in a position similar to clasped hands, with fingers interlocking and palms apart. That is to say, if the wrists represent the main wires to be joined and the fingers their component strands (though in this case we have only five instead of six), then the first finger of left hand should lie between thumb and first finger of right hand, and first finger of right hand between first and second of the left, and so on. From this stage, of course, the jointing goes on as usual, binding each set of components round the main wire of other side of joint.

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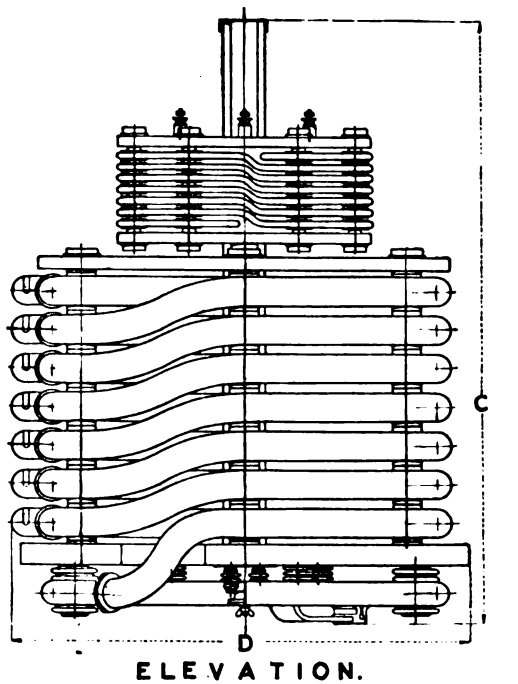

Transmitting Jigger, 20-25 kw.

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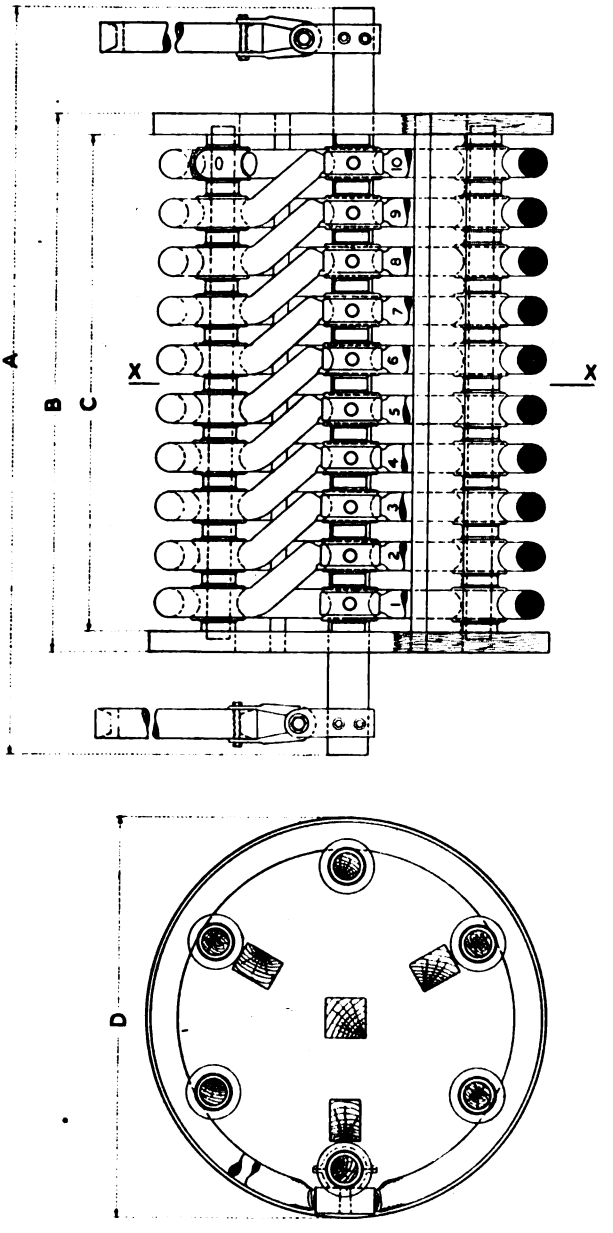

— SECTION ON XX —

Aerial Tuning Inductance for High Power Sets

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Wireless Telegraphy In the War

Silver Speech and Golden Silence.

The old Roman statesman-philosopher Cato laid down over 2,000 years ago the maxim, "Regard it as the first of virtues to restrain the tongue," and the same practice of restraint is inculcated in the popular English proverb, "Speech is silver, but silence is golden," a traditional saw which some authorities consider to be of Persian origin. Silence is often more significant than speech, and during the diplomatic manœuvrings which went on just before the Franco-Prussian War of 1870 the famous *Times* correspondent, Monsieur Blowitz, is reported to have said, as a justification for sinister forebodings: "Moltke is silent in seven languages." This celebrated Danish general, who organised the German army and led it to victory, held a high reputation for linguistic attainments.

Radiotelegraphy is but speech communicated through ether waves instead of sound waves; and there are occasions when the "golden rule" of *tace* applies to radiotelegraphy. We referred last month to the way in which wireless coast defences could detect the presence of hostile warships through radiotelegraphic messages sent out by the latter, even despite the friendly shelter of thick smoke screens. A most striking case, illustrative of the same point, occurs in the narrative of two Australian officers, unwilling passengers on the German raider *Wolf*, which returned to Germany towards the beginning of the year. These gentlemen, Colonel Strangeman and Major Flood, were travelling on board the s.s. *Matunga* at the time when she was captured. Since their arrival in England they have stated that in the course of their sojourn on board the Teutonic corsair they found out that none of the wireless messages which were sent out by the *Matunga* were missed by the foe. The *Wolf* kept two installations going night and day, always receiving but never sending messages. In the Indian Ocean her officers boasted that she received press news through her aerials in four different languages. The same precaution with regard to reception only was not improbably followed as a general rule by the wireless station established on a hill overlooking the pirates' lair, a natural harbour on the north coast of Dutch New Guinea. At least, any transmitting they may have dared to carry out must have involved serious risk of the discovery of the enemy secret.

The well-known naval correspondent, Mr. Ferraby, seems to have been recently treated to a cruise on a "Beef Trip." Some of the irreverent young gentlemen who officer His Majesty's destroyers appear to give this title to a certain class of convoy work, irrespective of whether the cargoes carried be margarine or pit-props, or barrels whose contents can only be guessed at.

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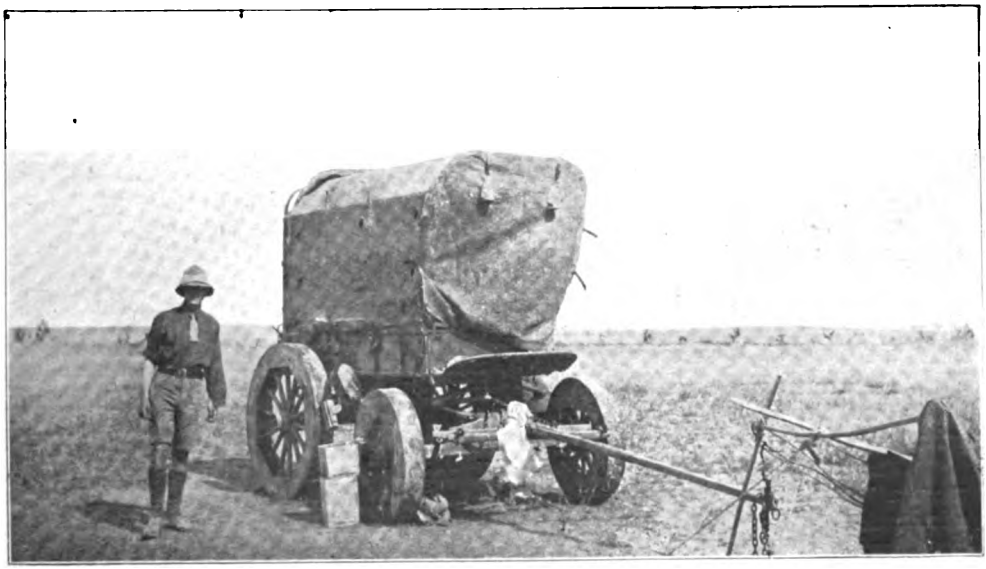
Mr. Ferraby, in the course of the tale he tells, describes how, as they go along, "a seaplane on watch catches sight of an enemy submarine and assails her with its "bombs. Three destroyers rush to the spot and send down depth charges. They "then circle round the spot once or twice: the seaplane glides down, whilst the "observer morses comments. The British convoy is too close to enemy-infested "waters for wireless to be used, and the three destroyers swing back to their places "in the mad quadrille."

You will notice that the reference here is to visual signalling, and it would appear that on such convoys the rule is usually laid down that this form of intercommunication should be utilised—semaphores and flag signalling by day, flash signalling by night. This rule is advisable on account of the sensitiveness of modern wireless instruments, and the danger lest the enemy may be attracted to a spot where his presence is not required. In such emergencies as those when wireless must perforce be utilised, the power employed is kept strictly within certain limits, and one of the problems which wireless experts are constantly endeavouring to solve is that of ascertaining with exactitude the range possessed by given aerials actuated by current of a given strength.

The enemy is as well aware as we are of the dangers accompanying radio speech, under certain circumstances, and our readers will find under the heading "Notes of the Month" in our last issue a reference to the Army Order of the German General Von Hutier, extending his prohibition thereof to telephone messages to or from points within seven miles' distance of the French or British lines. The tongue is sometimes termed "an unruly member" which requires curbing on occasion, though it must undoubtedly be reckoned one of the most useful weapons placed by nature in the armoury of man. The same admonishment applies also to wireless.

SPIES AND SPYING.

The cable companies in days not so very long since gone by used, for trade reasons, to put forward certain staple objections to the employment of wireless. Prominent amongst these stock indictments figured that of lack of secrecy, and it is a curious comment upon this superficially plausible piece of special pleading



FIELD WIRELESS "SOMEWHERE IN THE EAST."

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that we are now treated to so many items of fact and fiction with regard to the secret utilisation of radiotelegraphy by enemy spies! For our own part, we fear it is only too true that the highly organised spy system of our foes would be deprived of their main source of efficiency were it possible to cut off from them all possibility to utilise wireless; cable utilisation by the enemy vanished long ago.

A correspondent of the *Agenzia Volte*, working at Zurich, in Switzerland, recently telegraphed a communication to his principals at Rome that the central spy authorities at Berlin gave credit to radiotelegraphy for what they contend to be a fact, viz., the continuance in efficiency of the German system of espionage all over the world. The Allies and Neutral Governments have, so they assert, been unable to cripple it. Thanks to this efficient system, continues the correspondent, "the "German General Staff has been kept accurately informed concerning the sailing "of troopships from America and knows exactly how many American troops have "been landed in France up to the present." We cannot help seeing in the recent outspoken publication of figures on the part of the U.S.A. Government some recognition of the truth of this assertion.

Again, turn to the story of the sinking of the hospital ship *Llandovery Castle*, which we recount in our article on Maritime Wireless Telegraphy. You will notice that when the captain in command of the most recent victim of Hunnish methods of war was being interrogated by the U-boat commander he found the latter with so fixed an idea that the Red Cross vessel was carrying eight American flight officers as to be scarcely induced to credit that this was not the case, even when one of the Canadian Medical Staff appeared in person before him. The *Daily News*, in their account of the outrage, reported that there were eight medical officers on board the hospital ship until an hour before she sailed from Halifax, when one of them found himself obliged to remain on the other side. Our contemporary suggests that possibly some German spy saw the eight medical men on board and mistook them for American flight officers, either deceived by not having a clear view of the insignia of their office or coming away with the impression that they were Americans in disguise. The spy system which could advise the U-boat commander of such a suspicion in time for him to take action must be well served, and only wireless could do it.

On page 217 of our July issue we refer to the statement of an American writer that by means of small balloons a submarine can raise her wireless to the height of 1,000 feet or more, and that, under favourable conditions, the receiving range of these underwater craft might be estimated at about 3,000 miles. By "relaying" from one submarine to another, almost any distance might be covered in this manner. We have constant information with regard to what goes on in German submarines, and practically every returned visitor emphasises their continual use of radiotelegraphy. Such a persistent practice seems to point in a confirmatory direction; it is difficult to believe that submarine wireless is used for reception only, especially in view of the fact that the largely increased size of the later types would enable much more powerful installations to be carried.

The foregoing remarks refer, of course, more especially to the fact that, despite all the difficulties and dangers surrounding the *sending* of secret messages, the practice is far from having been "knocked on the head." With regard to their *reception* the matter is simple enough, and in the Government pronouncement issued in justification of the Sinn Fein arrests we find the deliberate official statement that Count Bernsdorff assured his employers at Berlin of the existence of numerous private wireless receiving stations in Ireland.

What is the moral of all this? Vigilance, and again vigilance! There is no more a "royal road" to the suppression of spy wireless than there is to complete elimination of the U-boat menace. *Vigila et ora* was the motto of some of our doughty forbears, and such a tradition is well worthy of being carried on by ourselves.

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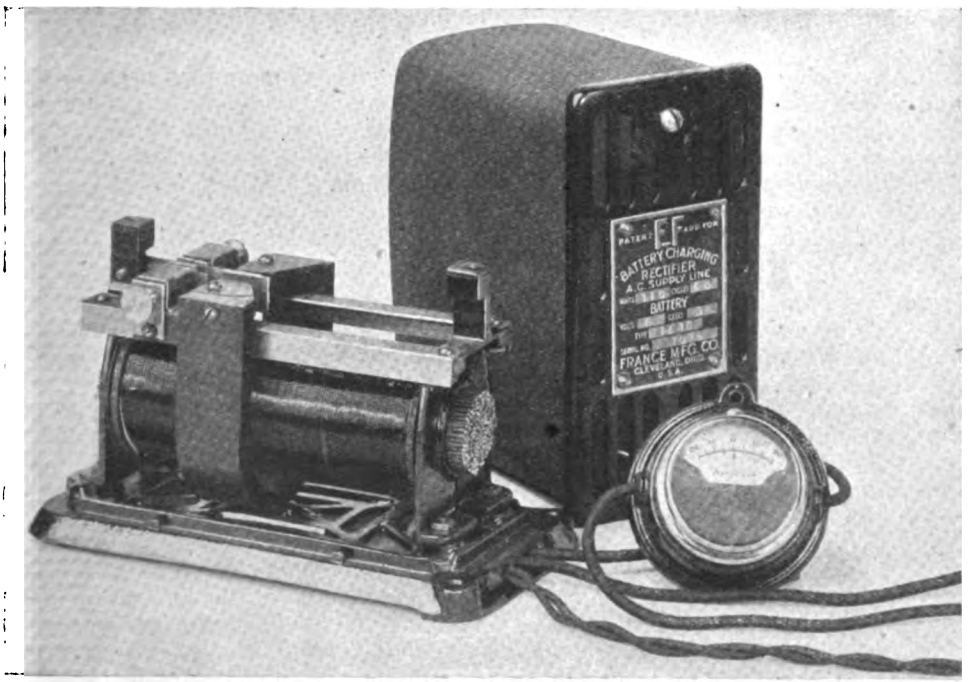
An Interesting Alternating Current Rectifier for Charging Accumulators

THE charging of accumulators from an alternating current source is usually effected through the agency of a motor generator consisting of an alternating current motor coupled to a direct current generator. Another method depends upon the use of chemical rectifiers. The former manner has the disadvantage of the high initial expense of the machine while the latter suffers from low efficiency, so that there should be a good opening for the American device shown in our illustration.

This full wave magnetic rectifier operates as follows. Firstly the line voltage is reduced to the proper charging voltage by a special transformer, and then the



current is rectified by means of the vibrating tongue, which, actuated by magnets in circuit with the alternating supply, automatically connects the line first to one pair of contacts, then the other in exact synchronism with the supply current. The device has thus no rotary parts, and being simple of construction, can be marketed at low cost.

Designed primarily for the charging of motor car starting and lighting batteries, it is yet obviously suitable for many other purposes including the charging of cells for wireless work. The smaller sizes can be rapidly connected to an ordinary lamp socket and the cells, if necessary, charged without removal from their normal position.

The rectifier is self-starting and is not affected by line failures. If the current

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is turned off the battery cannot discharge through the rectifier—as may happen with a motor generator and when the current is turned on the rectifier starts itself; thus night charging is safe and saves time. One type is shown in our illustration. It will charge a 6-volt battery, or two or more 6-volt batteries connected in multiple at an average rate of 10 to 15 amperes. An average starting and lighting battery can thus be charged overnight. The rectifier shown measures 5 by 7 by 9 inches and weighs 14 pounds.

The "Slave of Duty"

ONE of the most whimsical of the late W. S. Gilbert's librettos is that of the "Pirates of Penzance," which contains perhaps the most famous Policeman's Chorus in the world, of which the refrain runs thus:

"When Constabulary duty's to be done—
To be done.
The Policeman's lot is not a happy one—
Happy one."

An article recently appeared in the *Daily Chronicle* of more than usual interest and ability dealing with the life of a wireless operator at sea under war conditions. The subject was treated in just that "jesting about earnest" spirit which pervades the work of our classical British humourist; and—in case our readers may have missed reading it—they may find the following summary of interest. Of course, as our readers will notice, the language used has been "treated" journalistically. "Sparks" himself, that modern "slave to duty" (to employ the sub-title of Gilbert's "Pirates"), is reported to have said:—

"I think the worst time I ever experienced was one voyage when I had "as my wireless mate a fellow whose mother was a German and whom I was "told to watch, as he might be a spy. I tell you it got on my nerves, for we had "codes and all sorts of things in the wireless cabin, and I never dared let the "beggar be alone for long lest he should try some monkey tricks. The nearest "touch I think we ever had was when we were the last ship out of a patrol and "an urgent call came through, 'Come into —— bay immediately—we have "'an urgent message for you which we daren't send by wireless.'

"I asked for the Captain. When he came I pointed to the pad on which "I was writing down the signal. He read it over my shoulder and just as he "was going off to alter the ship's course I said, 'Look here, sir, this sounds O.K., "'but I've got an idea that this may be a German apparatus keyed to imitate "'a British.' (You see, after a bit of practice one can recognise the nationality "of the sender by the difference of the note and so forth. They are all different!) "The call was repeated, and the skipper felt he must obey it, but finally he looked "at me and I shook my head. At last he said, 'No! I'm hanged if we'll go, "'Sparks!' So we held on our course and got safely home. We heard "afterwards that there were two U-boats waiting for us and they'd have put "us down if we'd gone to that bay! . . . . . .

"With all its anxieties your daily task is most absorbing; though in the "tropics, when one is boxed up and simply dripping with sweat—so much so "that one has to put blotting paper under the arm with which one writes—you "certainly do find it a bit trying. Then, if you are busy picking up some very "distant message and a confounded ass comes blundering along and disturbs "you, it is not unlikely to try your temper 'some.' . . . . . .

"All the same, it's awfully interesting work, and I love it, and it is rather "good to feel one can be a bit of use now and again."

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The Suez Canal

An Operator's Voyage in the "Highway to the East"

By HAROLD WARD

WE were ten days out from London *en route* to the Far East before I managed to get in touch with Port Said, though I had heard him for several nights previously. Up to a year or two before the war the working of this station had been apt to be characterised by irregularity, a defect possibly due to the extremely dry nature of the surrounding land. Owing to this cause its position had been shifted more than once, and at the time of which I write the installation was located on the pier at the head of which stands the statue of the canal builder, M. Lesseps. A ship approaching from Malta is to some extent screened from Port Said by the Nile delta, and this may have been the cause of the trouble. When moored in the bay at Alexandria there have been occasions when I found myself unable to raise him, although the distance is comparatively short.

Two days later, after the usual exchange of MSG'S, we glided past the entrance pier and dropped anchor in mid-stream opposite the coaling wharves. As I leaned over the rail I seemed to "sense" that I had reached the Orient, the traditional "home" of strange beliefs and mysticism, which furnishes such invaluable local colour to novelists of every order. With this feeling fresh upon me I impatiently awaited the continuance of the voyage, so that I might penetrate still further into a land that was old when England was still a youngster as countries go. What entrancing mental visions arose within me of snake charmers and mystic rites, of sun-baked soil and swaying palms, and the whole galaxy of unfamiliar sights which combine to make the Far East the tourist's Mecca! Port Said, to my mind, is quite justly denominated "the gateway of the East."

A traveller from England, provided he has come by one of the regular routes, will here, for the first time, be in an unchristian port. I use the epithet in its literal significance, and any of my readers who boast of any acquaintance with the Mediterranean will readily agree that most of its ports are far from being Christianlike.

At Port Said the larger proportion of the inhabitants are followers of Mohammed, and I was very interested in the curious rites of this branch of "heathen" worship as I witnessed them in the mosque shown on page 275. Having always endeavoured to cultivate the "open mind" on matters of religion, I need hardly say that I use the word "heathen" in no invidious sense, employing it to signify merely a worship other than that of Christ. Many of the native Moslems are fully as law-abiding and refined as the average so-called cultured Christians. Given a suitable

THE LANDING STAGE AT PORT SAID.

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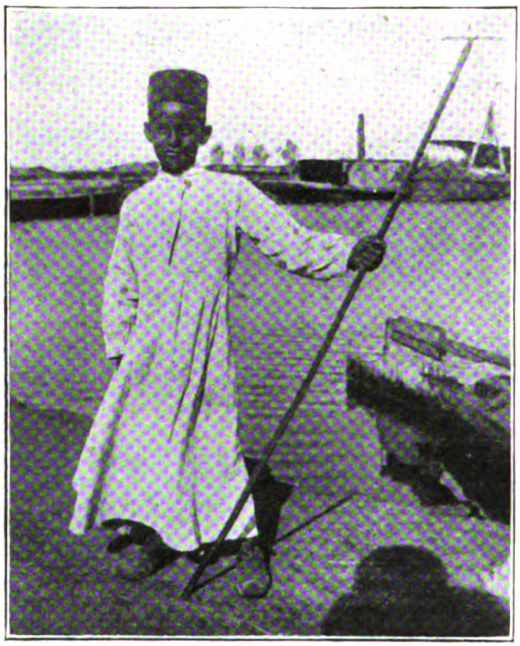
medium I should delight to enlarge upon my personal observations of the manner in which various races adhere to their accepted creed and carry out its precepts. The present, however, is not a fitting opportunity for so doing, and I will only venture to express the opinion, in passing, that it would prove of great subsequent interest to travelling wireless men if they were to take the chances afforded them of noting the characteristics of the followers of the different religions they may come in contact with, and of comparing them with one another.



A BOY CONJURER AT PORT SAID.

In peace times the majority of ships calling at Port Said only stay long enough to coal before passing through the Canal. This operation is performed by hundreds of Arab labourers, each carrying a small basketful of coal. These men run up a plank from the lighter to the ship's side, dump their load down the bunker hatches, and then return by another plank for a fresh supply.

At first the weird chanting, shouting and picturesqueness of the moving streams of swarthy workers provided all the entertainment necessary; but as the dust rose thicker and thicker the passengers, in twos and threes, went ashore in boats to see the sights and buy photos or faked curios. Those who landed first were "old-timers," and they made straight for a large café, where, in the shade and free from dust, they sipped from long glasses in which the ice tinkled most seductively.

As you walk about the streets fresh sights greet you all the time. In my own case I was immensely impressed by the number of beggars I encountered at every turn. Their diseased limbs and faces were often most repulsive, and the constant recurrence of these hideous specimens of humanity did much to spoil my pleasure. Their plaintive and haunting cries of "Baksheesh, mistair, baksheesh for ze poor Araab," rang in my ears for days after.

I did not take long to become "fed up" with the dirty, smelling streets of the Arab quarter; so, having "snapped" a few photographs, I joined the veterans at the café in the shade and waited my turn for showing practical appreciation of the tinkling ice. The boy whose photograph appears above passed among the tables where we sat, performing sleight-of-hand tricks, certain of which were voted to be well worthy of reproduction by some of our own legerdemain experts. His performance was carried on to the accompaniment of a running "patter" couched in what I took to be Arabic, interspersed with frequent appeals to Allah.

When I got back on board I was pleased to find the coal dust washed away and lunch ready. I may say that the latter, despatched in the saloon beneath the cool electric fans, was particularly welcome after the heat and dust ashore.

Shortly after this we commenced our passage through the Canal, and having advised the shore wireless station of the fact, I went on deck just in time to see a homeward-bound mail-boat pass out of the entrance.

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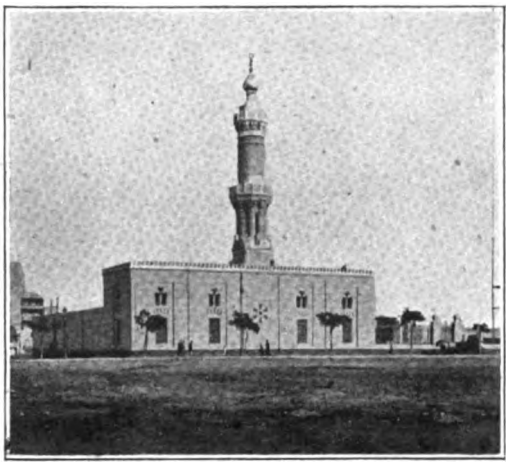
All the passengers at my table were agreed that it was hot, *very* hot, yet to our surprise most of the people on the passing ship were clad in warm clothes. We, for our part, were sporting "whites," and in despite thereof were feeling far from chilly! I found out afterwards that this apparent difference of feeling is frequently noticed; the fact being that, although to the outward-bounder Port Said is hot, to those returning from the Indian Ocean it appears (by contrast) chilly! Such is the difference of "the point of view"!

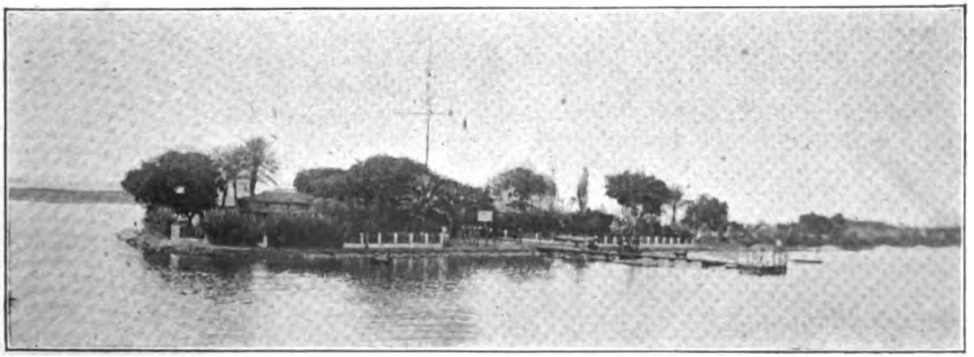


A MOHAMMEDAN MOSQUE.

The subject of the Canal bristles with statistics; but, as most people dislike them, I will only inflict those few figures which seem indispensable for bringing home the wonderful nature of this engineering marvel.

Building (or digging) was started in 1856 and the Canal was opened for traffic four years later. Thirty years afterwards it was enlarged to accommodate ships of 10,000 tons, this operation bringing the total cost up to £20,000,000. Great Britain owns more than half of the shares of the Company, though the administration is, or was, almost entirely directed by the French. The Canal is about 100 miles long, narrows to 210 feet wide in certain sectors, and has been dredged to a depth of 30 feet. These are pre-war figures, so that it might not be advisable to rely upon them for present-day navigation.

Leaving Port Said behind, and jogging along at about six knots, the Canal speed limit, we entered the Canal proper. During the first twenty miles or so the west bank is fringed with tall reeds, which sway in the wash from the ship's wake. Behind these there stretch away into the horizon the silvery waters of Lake Menzaleh, over whose surface the queer Arab dhows, with their huge lateen sails, glide as gracefully as swans. The word "lateen," by the way, possesses a rather interesting origin. It is said to be a corruption of the word "Latin," and is applied to that curious type of sail typical of most of the small craft one meets with in and around Latin waters.



THE SIGNAL STATION AT EL KANTARA.

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The eastern bank presents a striking contrast in the form of a limitless expanse of hummocky sand which glistens with fearful intensity under the quivering heat haze. Fighting under conditions such as this must be too awful for words. My eyes ached with looking at it, and I pictured to myself the terrible fate which has so often befallen a travelling party which had lost its way or failed to reach an oasis before the water gave out. I have been told, and can easily believe it, that the caravan routes are literally lined with the sun-bleached bones of men and camels.

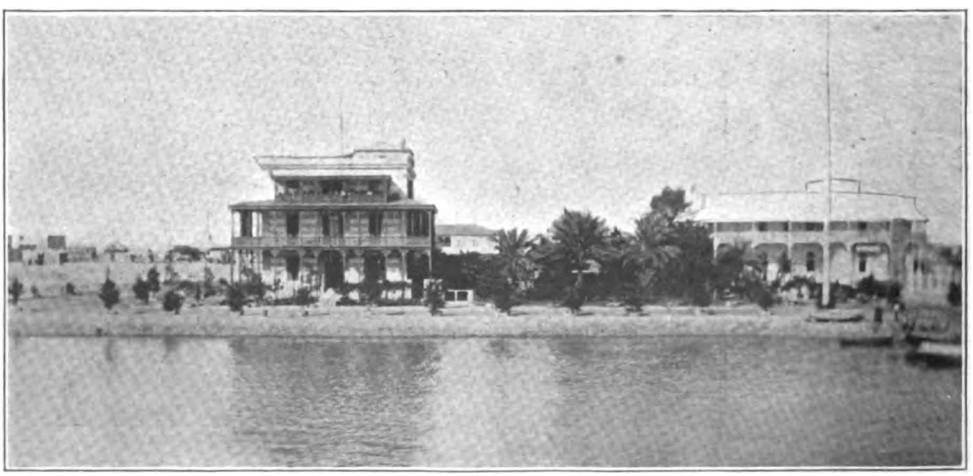
"BEGGARS INFEST THE STREETS AT EVERY TURN."

About ten miles from the entrance we passed Gare Ras el Esh, the first of the several stations controlling the movements of ships using the Canal. The stations are all much alike; they belong to the bungalow type of erections, and contain the keeper's quarters and office, surrounded by a few dried up palms. These low buildings, together with a small landing-stage and mast, whereon are hoisted the signals indicating whether the ship is to proceed or tie up and allow another to pass, constitute the only evidence of life in this otherwise desolate area.

After passing two more stations—Gare Tineh and Gare Le Cap—we reached El Kantara el Khazneh (the subject of our illustration on page 275), where we were fortunate enough to see a camel train being ferried across on large floats to the other side. As soon as the transit was effected, with much grunting of camels and shouting of men, they all settled down, apparently for a rest.

Having crossed through the two small Balah Lakes, we had to tie up to the bank at El Gisr, in order to allow another ship to pass; the Canal here not being wide enough for two ships to pass in mid-stream.

At El Gisr the caravan route from Syria to Cairo and beyond crosses the Canal



A VIEW OF THE WATERSIDE AT SUEZ.

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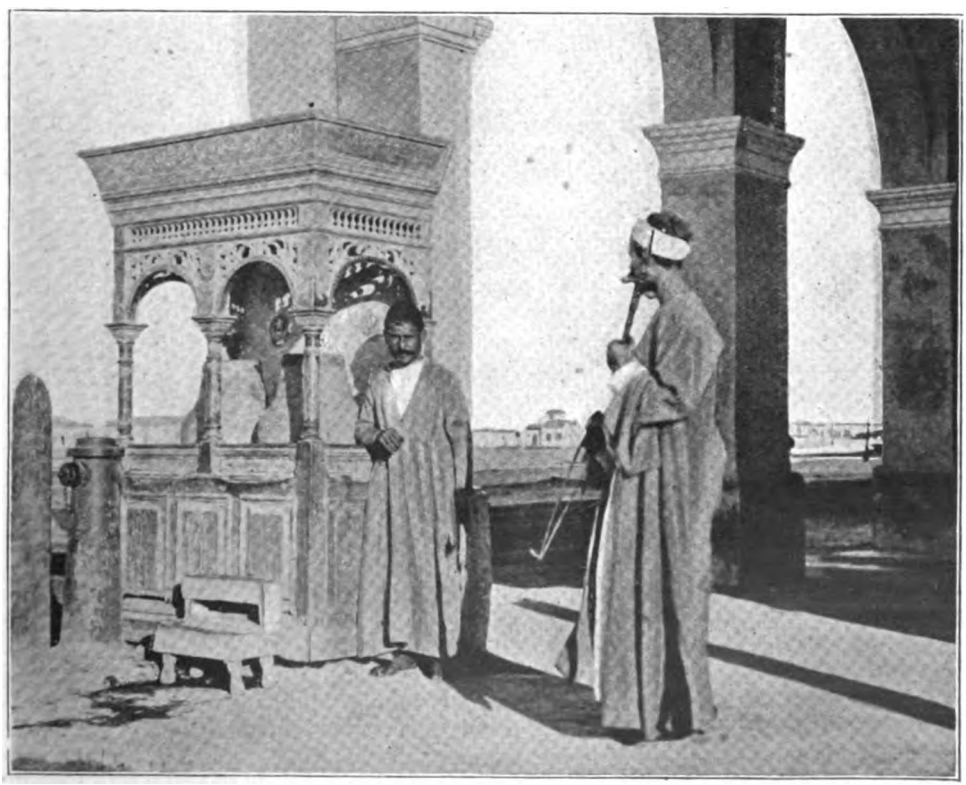
and, as it was now just upon sunset, we were privileged to see the people of a passing caravan at their evening prayers. Squatting down with their faces to the setting sun, they intoned out their evening chant, making deep obeisances with outstretched arms the while. All I could gather from the chant was " Allah il Allah," which is so frequently heard at all times of the day that it loses most of its religious savour. Indeed, Arabs use this term almost as freely as Frenchmen do " Mon Dieu," and with as little spiritual significance.

Sunset over the desert must be seen to be believed, the particular one of which I write glowing with such vivid hues that even Turner in his maddest moments might have hesitated before recording it on canvas. The brilliance of the lighting is indicated in the photograph which appears below.

Complete and inky darkness, relieved only by the brilliant stars overhead, followed quickly after, and, our searchlight having been started, we wended our deliberate way onward to the East. The Canal by night, as seen from the bridge, presents a weird appearance, to say the least of it. The velvety blackness on either side contrasts sharply with the sandbanks brilliantly lit up by the cold intense white glare of the searchlight. From time to time my ear would catch some strange howling, and then, as we rounded a slight turn in the Canal, I would be able to discern some carrion-hunting jackal slink away with a snarl into the " utter "—*i.e.*, *outer*—darkness.

There is little more of interest until Suez is reached, as most of the Canal route lies across Lake Timsah and the Great and Little Bitter Lakes, or, as the Arabs call them, Birket el Mamleh.

This eastern terminus I am unable to describe, because ships, as a rule, only stay to drop the pilot, and I was unable to go ashore. From what I heard of the place, however, it would appear to be very similar to Port Said, only on a smaller scale.



MUSIC AT SUNSET, LOOKING TOWARDS THE DESERT.

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Maritime Wireless Telegraphy

AN ATTEMPT AT "SPURLOS VERSENKT."

I SUPPOSE that it is not too much to take for granted, at this time of day at all events, that most of us desire to consider ourselves—and to be considered by others—as "broad minded." The evil of the insularity which used to be charged against the average Englishman consisted of an inability to understand the point of view characteristic of nations other than our own. The personal contact which results, or should result, from travel does much to dissipate this particularity in outlook. But travel is not possible to a large proportion of people, and does not monopolise the power of neutralising the limitations of our surroundings; judicious reading is fully as potent.

Does such a phrase as the one I have just used imply dry-as-dust study? Far from it. I can assure readers, on the strength of experience which now goes back a larger number of years than I find altogether pleasant to reckon, that one of the most widening, as well as most interesting, forms of reading consists in the systematic perusal of the magazines of a country other than our own. Nothing, for example, can give an Englishman a better insight into the American point of view than the regular perusal of magazines compiled and printed for a clientèle on the "other side."

* * * * * *

What has this to do with the sinking of hospital ships? Let me explain. Immediately before opening the newspaper which contained an account of the latest German outrage against humanity I was reading one of the most popular American weeklies, a magazine mainly devoted in normal times to fiction. The most striking account of aviation experiences it has been my lot to peruse appeared in that number. It was written by a young American flying man who has won pre-eminent distinction first among the French aviators and afterwards with Lafayette. He confessed that what first attracted him to the battlefields of Europe was the spirit of adventure, but went on to say that since he had been close to the heart of things a radical change had come over his whole mental attitude. He has seen with his own eyes the deeds of infamy whose details a perhaps over-prurient Press refrains from publishing, and his disgust with the nation guilty of these unspeakable crimes—a nation whose folk at home, women and men alike, rejoice in the outrages and applaud—has created within him, as within all the American volunteers in France;

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a settled conviction that the present struggle is a *crusade* in the truest sense of the word. The present generation of Germans is hopelessly corrupt, and the closer contact with that corruption which is being brought about in consequence of active participation in the struggle by the American nation as a whole is marked in every page, not only of the journal I have in mind, but throughout their periodic literature. The difference in tone between pre-war and post-war American journalism is becoming marked indeed.

* * * * * *

Let us not, for our own part, become sated with horrors and *blasé* with infamy. Consider the facts in connection with the *Llandovery Castle* torpedoing. Here we have a vessel devoted solely to the preservation of such sparks of life as may be left in the wretched human frames of victims of war, irrespective of nationality. International agreement, based on universal consensus of reasoned opinion, including that of the Central Empires, has declared such vessels *sacrosanct*. Certain conditions have been laid down; every one was fulfilled. With all her insignia of mercy flauntingly displayed in a manner which would be madness on the part of a vessel

THE UNVEILING AT WOLVERHAMPTON OF A MEMORIAL TO WIRELESS OPERATOR D. M. HARRIS, OF THE DRIFTER " FLOANDI " (SEE PAGE 298).

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subject to acts of war, the *Llandovery Castle* was not only torpedoed without warning but in such a way as to destroy her "top hamper," and thus deprive her of any opportunities of asking for assistance by wireless through the medium of her aerials. Radiotelegraphy, the great life saver, was deliberately forbidden to summon aid, and the Marconi operators strove in vain to transmit the SOS. Captain Sylvester, in command of the victimised ship, was twice summoned by the U-boat commander and subjected to a brutal cross-examination on board the German craft. The British shipmaster, in his sworn statement, reports that after his second summons had been answered, "the Germans opened fire at an unseen target." Out of the seven boatloads of survivors which left the vessel's side only one was left to tell the tale. That one escaped by the "skin of her teeth," after abortive efforts had been made to swamp her. The nursing sisters in the other boats have never been heard of since. Both the young wireless operators are included amongst the number of lost. There can be little doubt that we have here to deal with an attempt to render the ship of mercy *spurlos versenkt*.

The captain's boat, after having had two narrow escapes of being rammed—on one occasion being missed, it is said, by only a couple of feet or so—after pulling for about 70 miles, was picked up by H.M. destroyer *Lysander*, which immediately sent out wireless messages instructing other vessels to seek for the missing boats, herself carrying those rescued into Queenstown.

The semi-official German account denied that the German submarine was responsible, and attributed "the cause of the loss to a British mine." This "explanation" has been treated in the British Press as a gratuitous and barefaced lie. It is unnecessary so to regard it. The U-boat which perpetrated the crime has plainly not yet reached home, and perhaps will never return to her base. This denial may therefore be viewed as nothing more than the not unnatural tribute paid by hypocrisy to the moral laws which it outrages.

Mr. Havelock Wilson and the men of the Mercantile Marine for whom he speaks have pledged themselves to exact a definite penalty in a way which the British Government seems unable, or unwilling, to do. Their virile and determined course of action is being joined by the seamen of other nationalities.

OUR GALLANT TRAWLERS.

WE are glad to note, in the account of the plucky little engagement fought by six small armed trawlers against a giant submarine, specific acknowledgment of the gallantry displayed by the R.N.V.R. wireless operator. WIRELESS WORLD readers will probably recall this little "Epic of the Sea," which was recently allowed publicity by the British Admiralty. We often read such phrases (not altogether devoid of a journalistic sting) as "our Silent Navy"; but a silence which can be broken to such good purpose as this is worthy not only of respect but honour.

One of the newest and largest type of U Boats, shortly before 6 o'clock in the morning, opened fire at about 7,000 yards on six British armed trawlers The German had two 6-inch guns, whilst the trawlers were but lightly armed, and the former was as superior in speed as in armament. Scorning to yield, the little British flotilla swung into line ahead and bore up for action. Though swept by gunfire, the British maintained their line, and the unequal artillery duel continued until the trawler commanders found themselves threatened with lack of ammunition, and the R.N.V.R. officer, in charge of the leading vessel, made ready the signal, "Prepare to ram." As the German, however, closed to shorter range, the trawler second in line placed a shell on the after part of the pirate, and five minutes later the flagship scored two direct hits, the second shell bursting at the base of the big conning tower. A huge cloud of smoke ascended and enveloped the submarine. What happened then is doubtful, but when the smoke cleared away the enemy had disappeared.

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The Evolution of the Thermionic Valve (V.)

(Continued)

By R. L. SMITH-ROSE, B.Sc., A.R.C.S., D.I.C., Student I.E.E.

Read before the Students' Section of the Institution of Electrical Engineers on January 22nd, 1918.

NOTE.—The first part of this valuable paper appeared in our April issue, pp. 10 *et seq.*

(6) THE USE OF THE THERMIONIC VALVE AS A RECTIFIER, AMPLIFIER AND AS A GENERATOR OF ALTERNATING ELECTRIC CURRENTS.

As it is not the object of the present paper to describe in detail the various circuit arrangements and their mode of operation, brief mention only will be made, in conclusion, of the more immediate applications of thermionic valves. For further details concerning the practical operation of these, reference may be made to some recent articles in the WIRELESS WORLD,* and also to a paper read before the Institute of Radio Engineers by E. H. Armstrong in 1916.†

The manner in which these valves may be used as detectors and rectifiers of electric oscillations for use in radio-telegraphic receiving stations has already been described in connection with the Fleming valve and De Forest audion. The pliotron may be used in an exactly similar manner to the audion, except that if it is attempted to use a condenser in series with the grid, as shown in Fig. 8, it will be found necessary to shunt the condenser with a high resistance and often to place a battery of a few volts in series with the resistance, to prevent the accumulation of a large negative charge on the grid.

An interesting discovery was made by Mr. W. C. White, of the G.E.C. Research Laboratory, on the effect of a very minute trace of certain gases introduced into a pliotron valve which greatly increases the sensitiveness of the device as a detector.‡ To produce the desired pressure in the tube and maintain this constant, he used the vapour from a small quantity of silver-amalgam placed in the tube. The quantity of gas in the tube is very much less than that in the audion and there is no evidence of positive gas ionisation. In this condition the characteristics of the tube show a kink, as in Fig. 17, indicating a region of instability for a certain value of the grid potential, and

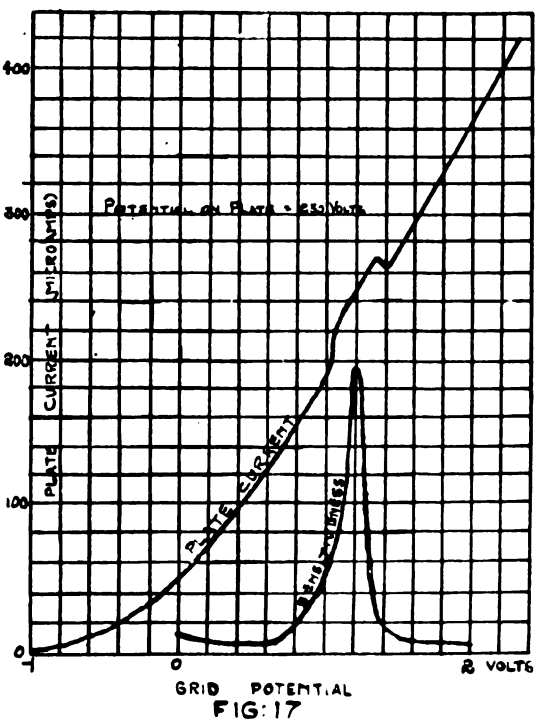

FIG: 17

* WIRELESS WORLD, v., pp. 158, 230, 236, 489, 594, 662 (1917).
† E. H. Armstrong, *Electrician*, lxxvi., p. 798 (1916).
‡ See Refs. 23 and 24.

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in this condition the sensitiveness of the detector is very high. The explanation of this phenomenon is rather obscure.

In 1916 an account was given by Mr. G. S. Meikle of the use of thermionic rectifiers for charging batteries at central stations.* For this purpose it is inconvenient to use the kenotron type of valve, owing to the high voltage necessary for its operation. Consequently a gas-filled rectifier is used, and it was found in the course of its development that the introduction of pure argon into a kenotron tube at a pressure of from 3 to 8 cms. of mercury, while being quite effective in supplying positive ions to neutralise the space charge effect had no influence on the thermionic emission from the tungsten cathode and caused no serious disintegration of the latter. Valves on this principle may be designed to rectify currents of from a few milli-ampères up to several ampères, at potentials of from two or three up to several thousand volts.

A further description of this commercial type of argon-filled rectifier with a charging capacity of from 2 to 6 ampères was given recently by R. E. Russell, who designates this valve by the term "tungar rectifier."†

The use of the three-electrode type of valve as an amplifier of the small electric oscillations occurring in the receiving circuits of a radio-telegraph station were described in the chapters on the audion and the Lieben-Reisz valve. This amplification may be carried out in either the radio-frequency or audio-frequency circuits, or both, as desired, since the operation of all the types of thermionic valves described is independent of the frequency of the currents used.

For this reason the valves may be employed for the amplification of speech currents in ordinary wire telephony, where it is desired to extend the range of speech transmission, or where the line is already so long that the attenuated currents are not sufficient to give an audible sound when the receiver is connected direct. In introducing an amplifier in this manner, the leads previously connected to the receiver are connected between the grid and the filament, the receiver being either transferred to the plate circuit or connected to the secondary of a transformer, the primary of which is connected in the plate circuit. Several valves may be connected in cascade as described in connection with the audion, in order to obtain increased amplification.

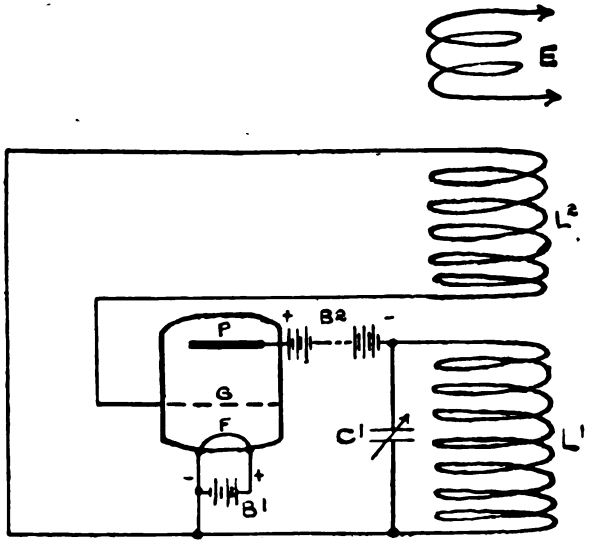

FIG. 18.

Thermionic valve relays were used for the amplification of speech currents on this principle in the recent long-distance telephone tests between New York and San Francisco, a distance of 5,000 kilometres. Similar and more recent use of these valves as telephone relays on the line between Paris and Marseilles have shown that this application can effect a considerable saving in the amount of copper which must be used in the laying of trunk telephone lines.

The property of the three-electrode thermionic valve of amplifying small alternating currents enables it to be used as a generator of electric oscillations, with but a slight

* G. S. Meikle, *Electrical Review*, lxxviii., p. 472 (1916).
† R. E. Russell, *General Electric Review*, March, 1917.

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modification of the circuit arrangements. Instead of the alternating potential being supplied from an external source, it is supplied from one winding $L2$ of a transformer, the other winding L^1 of which is connected in the plate circuit as shown in Fig. 18.

If we apply a small oscillatory potential-difference to the grid circuit a magnified oscillation will result in the plate circuit. If the transformer connections are correct this increased current in the plate circuit will induce a further increased potential variation in the grid circuit. This will result in a further increased current in the plate circuit, and so the two circuits will continue to react on each other and the amplitude of the oscillations in the plate circuit will continue to increase until the whole system settles down to a steady state. By this means fairly powerful oscillations may be set up, depending upon the size of valve used, and by means of a third coil, E, coupled to the transformer, the generated alternating current may be drawn off and used for any purpose required.

The frequency of the oscillations is determined by the dimensions of the self-induction, L^1, and capacity, C^1, in the plate circuit, and by varying these the frequency may be altered within wide limits. Mr. W. C. White* has described experiments in which a pliotron was made to give oscillations at the extreme frequencies of one-half cycle per second and fifty million cycles per second.

The thermionic valve in this way provides a very convenient generator of perfectly steady, pure sine wave alternating current, the frequency of which may be varied at will. The currents can be obtained of almost any desired amplitude by using a valve of suitable dimensions and characteristics. Pliotrons can be constructed with an output of 1 kilowatt, and greater powers than this can be easily obtained by connecting several of these in parallel. Used in this manner the thermionic valve would appear to provide an ideal generator of continuous oscillations for use both in radio-telegraphy and radio-telephony. In this application it is noteworthy to remark that some 300 to 500 of such oscillating valves were used in the successful long-distance wireless speech tests carried out in 1916 between Arlington, U.S.A., and the Eiffel Tower, and between Arlington and Honolulu, a distance of 5,000 miles.†

The smaller form of the oscillating valve has also provided a very simple form of detector for use in continuous wave radio-telegraphy, on the heterodyne principle. The valve receiver is arranged to generate local oscillations of a frequency somewhere in the neighbourhood of those arising from the incoming signals. Those two frequencies, both too high to be audible themselves, are made to interfere, producing beats of a frequency equal to the difference of the two original frequencies, and audible in the telephone receiver as a musical note.

Possibilities and Impossibilities

THE wonders actually performed by wireless possess so many characteristics which are classified by the average "lay" mind as miraculous, that a serious hearing is now secured for all sorts of (apparently) fantastic projects which would in old days have been dismissed with contumely. Frequently all that it is possible to say about them is that, whilst they do not run counter to any known theory, the practicability of the whole depends upon detail working which—not unnaturally—is almost invariably lacking. To such a class belongs the "automatic soldier" suggestion, which recently found a place in the pages of our enterprising contemporary the *Daily Mail*. The invention is credited to "A Danish Engineer," and the "soldier" in question consists of one steel cylinder working inside another, the larger one being sunk vertically in the ground.

"Through a very simple mechanism which is set in motion by wireless telegraphy, the inner cylinder rises from the ground, and at the same time an automatic rifle mounted therein fires 400 shots in any given direction."

* W. C. White, *General Electric Review*, September, 1916.
† P. R. Coursey, WIRELESS WORLD, iv., p. 220 (1916).

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Notes of the Month

The "Polite Pirate" Utilises Wireless.

Not long ago a series of U-boat sinkings took place off the American coast, and details of what occurred have recently come in by mail. These particulars furnish, in a way that no brief telegraphic communication can do, a confirmation of the theory that this interlude of war constituted an attempt, on the part of the German authorities, to ascertain what the effect would be on the American public rather than any serious essay to hinder American transportation. Incidentally, the fuller accounts of what happened on the occasion of the sinkings in question go to prove (if proof be necessary) that the horrors perpetrated by Hun commanders in other waters are strictly in accord with orders issued from Headquarters. In marked contrast to the "frightfulness" and studied brutality displayed in the perpetration of such crimes as the sinking of the *Llandovery Castle*, the Teutonic captain assumed the *rôle* of the "Polite Pirate," treating his victims to wines, cigars and general hospitality. According to more than one American captain's reports, the Yankee officers would seem to have been treated more as "trippers" than foes. They were shown over the ship, regaled with exhibitions of speedy submersion, introduced to the German wireless operators at work, and enabled to witness the Teutonic "Sparks" listening-in to the news bulletins sent by wireless from America.

Wireless Time Signals in Switzerland.

Since August, 1916, Swiss telephonic subscribers have, in consequence of the sequestration of all wireless telegraph apparatus in the Helvetian Federation, been allowed the privilege of receiving telephonically every day, between 10.56 and 11 a.m., the time signals radiated from the Eiffel Tower, received at Berne and repeated simultaneously. Our French contemporary *La Nature* states that a recent communication from Monsieur Paul Ditisheim to the Swiss Geophysical Society reports that this telephonic service has been found by experience to work thoroughly satisfactorily. The signals transmitted under the arrangement above mentioned only differ by ·087 seconds from the time of their transmission from Paris.

Radiotelegraphic Munificence.

The possession of great riches, we are often told, involves as great a responsibility. Were that doctrine more consistently carried out in practice, we should probably hear very little of socialistic nostrums. In some outstanding instances this wealth-responsibility is, however, recognised by the fortunate possessors. Prominent amongst these public-spirited millionaires we may count Sir Basil Zaharoff, whose foundation of Chairs of Aviation at the Universities in Paris, Petrograd and (just recently) London, affords practical testimony of his high-minded liberality. On the occasion of a visit paid by Sir Basil to Greece, in pursuance of certain projects designed to assist the cause of the Allies, he made a donation for

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the special purpose of establishing at Athens a radiotelegraphic station there. The amount of the handsome cheque handed over for this object was no less than £100,000.

A Striking Sign of Rapid Expansion

British, French, Dutch and German Suggestions to meet an International Situation.

ONE branch of the activities of the International Radiotelegraphic Bureau at Berne consists of the allocation of Call Letters to the stations belonging to the various nations who are parties to the International Radiotelegraphic Conventions. The arrangement up to the present has been that each station should have a Call Signal of *three* letters. It was thought at the time when this was settled that the various combinations possible would suffice for many years to come, but so rapidly has radiotelegraphy developed that it has for some time past been evident that the possible combinations would ere long be exhausted. Various solutions have been proposed; and in Circular No. 98, dated at Berne on June 18th last, we find the replies which have reached the Bureau after the first enquiry five months ago on the subject of the proposal of the British Administration, printed in Circular No. 93 of January 1st, 1918. This proposal consists of a suggestion that, after the combinations on the present system are exhausted, each Administration shall be able to use signs of *four* letters formed by the letter T followed by one of the combinations reserved for its use.

Out of 71 Administrations, 28 have replied to the initial enquiry of Circular No. 93. Of these replies 23 approve the British proposal. The Administrations of Germany and the Netherlands each made counter-suggestions. The former approves of the adoption of combinations of four letters with the addition of the letter T, to *follow* the triple combination instead of preceding it. The Netherlands, whilst not objecting to the British solution, think that it would be better if the letter T were replaced by the letter P, basing this modification on an idea that the use of T might give rise to confusion in cases where transmission was inadequately carried out. France, Morocco and Tunis are of opinion that it would be expedient to postpone the consideration of the matter until the meeting of the next International Radiotelegraphic Conference.

No more striking evidence could be adduced of the rapid strides made in radiotelegraphy. With regard to the alternatives mentioned above, we cannot help being impressed with the reasons adduced for the German modification of the British proposal. Telegraphists have become familiar with the combinations allocated to the various nationalities, and this familiarity would be utilised if the fourth modifying letter followed, instead of preceded, the present triple letter signal. Moreover, seeing that all combinations starting with T are allotted, under present arrangements, to Germany and Turkey, if an additional T were added at the beginning, telegraphists familiar with present usage might possibly be liable to jump to the conclusion that the ship in question was German or Turkish. The same misunderstanding could not occur if T were added at the end.

The Dutch suggestion involves the insertion of an unnecessarily lengthy sign, and it is a hopeless task to attempt to provide against all the possibilities latent in the postulation of inefficient working which they suggest might result from the use of an additional index letter with a short morse symbol. Of course the Hollander's interest in P is easily understood; the combinations starting with that letter have, so far as at present allotted, been confined to Holland and Brazil. With regard to the French suggestion: are not our Gallic friends a little too optimistic with regard to the date at which it may be possible to hold an International Conference?

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Among the Operators

It is our sad duty, month by month, to record the death of the brave operators who have lost their lives at sea by enemy action and other causes in the wireless service of their country. Owing to the necessity of preventing the leakage of information likely to assist our adversaries the names of ships and localities of action cannot be published. With the exception of Messrs. Clarke, Crawford, Green and Millington, who died from natural causes, the lives of the operators mentioned this month have been sacrificed as the result of hostile activities. Both on our own part, and on that of our numerous readers, we extend to the parents and relatives of these young men, who so nobly upheld the "wireless tradition," the deepest sympathy in their sad bereavement.

MR. REGINALD COMER BOND, formerly employed as a clerk in the Accountant's and the Traffic Department of the Marconi International Marine Communication Company, Ltd., was born at Peckham on January 5th, 1894, and educated at St. Mark's College Schools, Chelsea, and College de St. Germain-en-Laye, France. He was trained at Marconi House School and, after gaining the P.M.G. Certificate, appointed to the Operating Staff in August, 1914.

Born at Rutherglen, Lanark, on September 10th, 1899, MR. JOHN FLEMING DRUMMOND was educated at MacDonald Public School, Rutherglen, and Skerry's College, Glasgow, and trained at the North British Wireless Schools, Ltd., in that city. He received the P.M.G. Certificate, and was given an appointment by the Marconi Company last September.

MR. HAROLD DOUGLAS HILL was born at Handsworth, Birmingham, on October 12th, 1899, and went to the Albert Road Council School and King Edward's Grammar School, Aston. Commencing his career in an insurance broker's office, he subsequently attended the City School of Wireless Telegraphy, Ltd., Birmingham, and obtained the P.M.G. Certificate. Mr. Hill's service with the Marconi Company started in April of this year.

Of Welsh birth, MR. BRINLEY THOMAS HUGHES, twenty-two years old, was born at Halfway, near Llanelly. He received his education at Dafen County Council School and attended the evening class at Swansea Technical School. Starting life as a carpenter and joiner, he turned his attention to wireless and was trained at the South Wales Wireless College, Ltd., Swansea, where he gained the P.M.G. Certificate. Mr. Hughes was appointed to the Marconi Company's Staff on September 16th, 1917.

MR. CHARLES GERALD MARKWELL was born at March, Cambridgeshire, on November 27th, 1899. He was educated at the South District Council School, March, and at March Grammar School. Before receiving training in wireless telegraphy at Marconi House School he was an engineer's apprentice. On qualifying for the P.M.G. Certificate he was placed on the staff of the Marconi Company on May 6th this year.

High Bickington, North Devon, was the birthplace of MR. CECIL FRANK NEWBERY eighteen years ago. After receiving his education at the Council School there he was employed as a solicitor's clerk, afterwards being trained at Marconi House School. In April last he won the P.M.G. Certificate and joined the Operating Staff of the Marconi Company.

MR. THOMAS STANLEY SMITH, born at Cockermouth on January 8th, 1899, was educated at Weston Lodge High School, Cockermouth, and started his career as a surveyor's pupil. His wireless training was received at the Manchester Wireless Telegraph Training College, and, on receipt of the P.M.G. Certificate, he proceeded to sea in the Marconi Company's service in June, 1917.

MR. FRANK WILLIAM STALLY was born on September 27th, 1900, at Fulham, and received his education at Northfields School, Ealing. He was in the employ of

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ROLL OF HONOUR.

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Honor Bros., Hanwell, as assistant wireman, subsequently leaving that firm to take up wireless telegraphy. Trained at Marconi House School, Mr. Stally qualified for the P.M.G. Certificate, and entered the service of the Marconi Company on February 2nd, 1917.

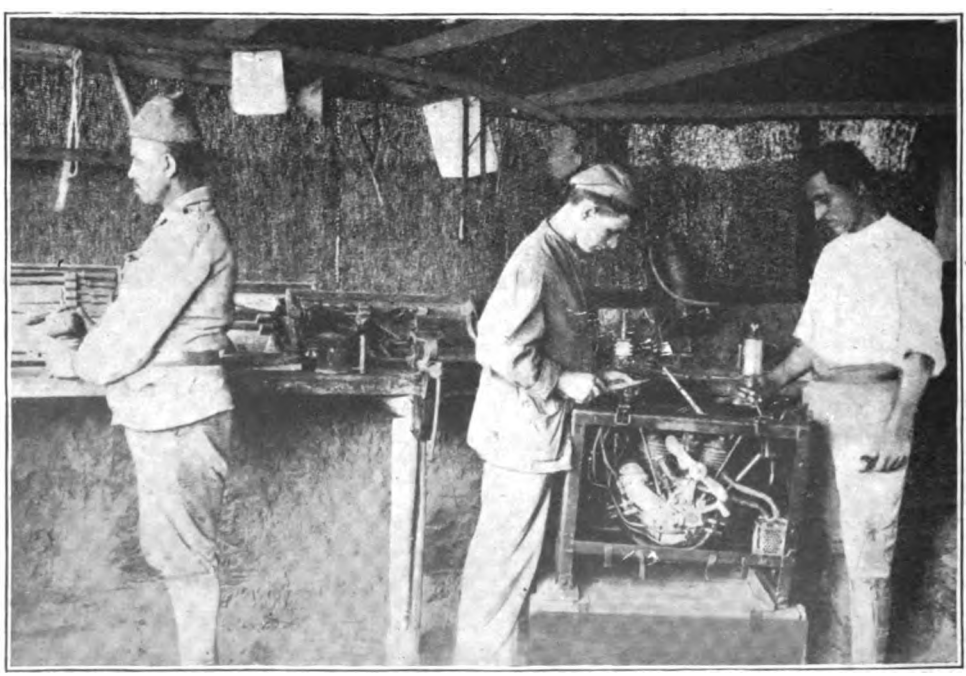
Born on June 9th, 1900, at East Plumstead, MR. HENRY WILLIAM CRAWFORD was educated at the Higher Grade School, Greenock, and afterwards was employed as a fitter in the Royal Naval Torpedo Factory at Greenock. Trained in wireless telegraphy at the North British Wireless Schools, Ltd., Glasgow, he obtained the P.M.G. Certificate, and joined the Marconi Company's Staff on June 16th, 1917.

Formerly a clerk with the London City and Midland Bank, Ltd., MR. WILLIAM HENRY MILLINGTON was born at Birmingham on November 16th, 1899, and educated at King's Norton Secondary School. He took a course of training in wireless telegraphy at the Birmingham Technical School and received the P.M.G. Certificate. Mr. Millington entered the Marconi service in February last.

MR. EVANDALE CROWTHER GREEN was born on March 8th, 1896, at Norwood, and attended college at Bishop's Stortford. His training in radiotelegraphy was received at the British School of Telegraphy, Ltd., London. On gaining the P.M.G. Certificate Mr. Green was placed on the Marconi Company's Operating Staff in July, 1915.

An Irishman, MR. JAMES GOGARTY CLARKE was born at Ballinasloe on August 22nd, 1895, and received his education at the Town School and at St. Joseph's College. He was a student at the Liverpool Wireless Telegraph Training College, and qualified there for the P.M.G. Certificate. Mr. Clarke was placed on the sea-going staff of the Marconi Company on November 9th, 1913.

Adjusting Turkish Transmitting Gear



The above photograph (for which we are indebted to the courtesy of Miss W. F. Haynes) depicts the adjustment of the transmitting gear of Turkish field wireless.

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Instructional Article

NEW SERIES (No. 5).

EDITORIAL NOTE.—Below we give the fifth of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

Sine Curve with Logarithmic Decrement.—If it be imagined that the length of the moving radius *OP* decreases as the revolutions continue the point *P* will describe a spiral curve, as in Fig. 22, and the harmonic motion in such a case can be represented by a sine curve the amplitude of which decreases instead of remaining constant like that of the simple sine curve of Fig. 21.* The damped oscillations of a pendulum or of the current in an oscillatory circuit are familiar examples following the sine law modified by the introduction of a logarithmic decrement.† In each case, during the first swing some of the energy imparted to the system is frittered away so that for the succeeding swing there is less energy available and consequently it is of smaller amplitude. This process continues until the original energy has been used up or wasted, as the case may be, and then the oscillations are said to be "damped out." In the ordinary wireless telegraph transmitter, where a condenser is discharged across a spark-gap and through an inductive circuit the value of the current in the circuit at any time during the discharge is shown graphically by a curve of similar type to that in Fig. 22, and as it is desirable that the student should thoroughly understand the sine law as applied to damped high-frequency oscillations we shall deal with the subject somewhat more fully than would usually be considered necessary for an elementary article; it must be assumed, however, that he knows how to use logarithms and that he understands or will ascertain from his text-books what a log. dec. is.

The equation of a sine curve with a log. dec. is of the *form*

$$y = b\varepsilon^{-ax} \sin (cx + g)$$

and it may be encountered written as

$$i = I_{max}\, \varepsilon^{-at} \sin \theta$$

or

$$i = I_{max}\, \varepsilon^{-\delta nt} \sin \theta, \text{ or, } i = I_{max}\, \varepsilon^{-\delta nt} \sin 2\pi nt.$$

but all four *forms* are alike and although they may appear complicated they are really simple. For instance, $i = I_{max}\, \varepsilon^{-\delta nt} \sin \theta$ is clearly nothing but the now familiar equation (1) $i = I_{max} \sin \theta$ multiplied by $\varepsilon^{-\delta nt}$, and might be written $i = (I_{max} \sin \theta) \times \varepsilon^{-\delta nt}$. $\varepsilon^{-\delta nt}$ is a correcting factor for the damping at any time t, and, supposing that we are dealing with the current in an oscillatory circuit, the equation simply means that the current in the circuit at any instant is equal to the product of:

(1) I_{max}, or the value of the current at the initial amplitude.
(2) sin θ, or the sin of the angular displacement at the instant t.

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* See page 240 of July issue. † Called hereafter log. dec.

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(3) $\epsilon^{-\delta nt}$, or the base of Napierian logarithms raised to the negative power of the product of (*a*) the log. dec., *d*.
(*b*) the frequency, *n*.
(*c*) the time, *t*.

By taking appropriate figures this equation can be whittled down to the form, $i = \epsilon^{-\delta nt}$, when it will be much simpler to handle in the examples we shall work out in order to test the truth of the equation. We begin with

$$i = I_{max}\ \epsilon^{-\delta nt} \sin \theta.$$

Now, as no sine can be greater than 1 we will take a case in which $\sin \theta = 1$. This gives us

$$i = I_{max}\ \epsilon^{-\delta nt} \times 1.$$

To reduce this further we can also make I_{max} equal to 1, when our equation becomes

$$i = 1 \times \epsilon^{-\delta nt} \times 1 = \epsilon^{-\delta nt}.$$

We took the case where $sin\ \theta = 1$, and reference to Fig. 22 shows that $sin\ \theta = 1$ when OP has moved to the position OP^1, for θ is then 90°, the sine of which is 1. Calling the frequency (*n*) 2, if P completes two revolutions every second it will take one-eighth of a second to reach P^1. Hence in this case $t = \frac{1}{8}$, and we can write

$$i = \epsilon^{-\delta \times 2 \times \frac{1}{8}}$$
$$= \epsilon^{-\frac{\delta}{4}}$$

To get rid of the negative sign of the exponent we must take the reciprocal of the expression, hence

$$i = \frac{1}{\epsilon^{\frac{\delta}{4}}}$$

We shall now consider two cases: (1) in which there is no log. dec.; (2) in which there is a log. dec. of 0·15.

Case I.—If there is no log. dec. the current follows the simple sine law $i = I_{max} \sin \theta$, and as we took I_{max} and $\sin \theta$ equal to 1 in each case, $i = 1 \times 1 = 1$ (when $t = \frac{1}{8}$) and the amplitude is 1 throughout every cycle. The same result can be obtained by using the formula

$$i = \frac{1}{\epsilon^{\frac{\delta}{4}}}$$

for there being no log. dec. we can write

$$i = \frac{1}{\epsilon^{\frac{\delta}{4}}} = \frac{1}{\epsilon^{0}} = 1.$$

Thus it is seen that $I_{max} \sin \theta$ is multiplied by $\epsilon^{-\delta nt}$ to correct for the log. dec., and that if there is no decrement $\epsilon^{-\delta nt}$ equals 1, a multiplier which leaves the expression $I_{max} \sin \theta$ unchanged.

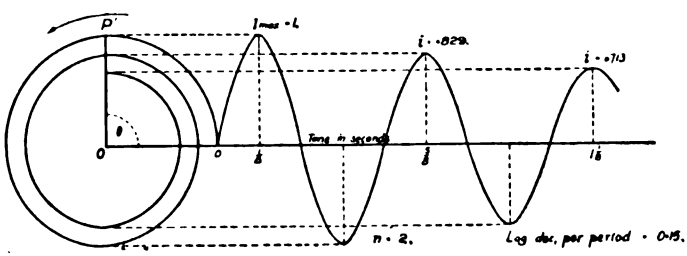

FIG. 22.

Case II.—It now remains to examine the effect upon *i* of a log. dec. of 0·15. The initial amplitude

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(or I_{max}) of 1 is reached in one-eighth of a second, during which time P moves to P^1 (Fig. 22). The next amplitude *in the same direction* will be attained when P again reaches P^1 and t will then be $\frac{5}{8}$ sec.—*i.e.*, at the completion of the fifth quarter-cycle.

$$i = I_{max}\, \epsilon^{-\delta n t} \sin \theta$$
$$= 1 \times \epsilon^{-\delta n \frac{5}{8}} \times 1.$$

As $\delta = 0{\cdot}15$, $\epsilon = 2{\cdot}718$ (always) and $n = 2$, we can write

$$i = 1 \times 2{\cdot}718^{-0{\cdot}15 \times 2 \frac{5}{8}} \times 1$$
$$= \frac{1}{2{\cdot}718^{{\cdot}1875}}$$

Simplifying this fraction,

$$\log 2{\cdot}718^{{\cdot}1875} = {\cdot}1875 \log 2{\cdot}718$$
$$= {\cdot}1875 \times {\cdot}4343$$
$$= {\cdot}0814$$
$$\text{antilog } {\cdot}0814 = 1{\cdot}206.$$

Whence $i = \frac{1}{1{\cdot}206} = {\cdot}829 =$ Second amplitude in same direction.

The third amplitude *in the same direction* is attained when $t = 1\frac{1}{8}$ sec. Applying the formula

$$i = \frac{1}{2{\cdot}718^{{\cdot}3375}}$$

and simplifying

$$\log 2{\cdot}718^{{\cdot}3375} = {\cdot}3375 \log 2{\cdot}718$$
$$= {\cdot}3375 \times {\cdot}4343$$
$$= {\cdot}1465$$
$$\text{antilog } {\cdot}1465 = 1{\cdot}402.$$

Whence $i = \frac{1}{1{\cdot}402} = {\cdot}713 =$ Third amplitude in same direction.

The log. dec. may be defined as the Naperian logarithm of the ratio of two successive amplitudes and may be given per cycle or per half-cycle, that is, the two amplitudes chosen may both be in the same direction (both positive or both negative), or one may be in one direction and the other in the opposite direction. In the present case 0·15 is the log. dec. **per cycle** and we have three consecutive amplitudes in the same direction, viz., 1, ·829 and ·713, the last two being found by our formula. By definition, therefore, δ ought to equal $\log_\epsilon \frac{{\cdot}829}{{\cdot}713}$.

$$\delta = \log_\epsilon \frac{{\cdot}829}{{\cdot}713}$$
$$= \log_\epsilon 1{\cdot}162$$
$$= (\log_{10} 1{\cdot}162) \times 2{\cdot}302^*$$
$$= {\cdot}0653 \times 2{\cdot}302$$
$$= 0{\cdot}15$$

which is the value we assigned to δ.

The student should not fail to draw on squared paper a series of curves similar to that in Fig. 22, taking various values of δ and I_{max} and calculating the ordinates from the equation we have given. He can then compare the ratio of

* To find the log. of a number to the base ϵ note that we multiply the log. of the number *to the base 10* by 2·302. In general, $\log_\epsilon x = (\log_{10} x)\, 2{\cdot}302$.

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the heights of two successive ordinates with ε^{δ}, when he should find that $\frac{I_1}{I_2} = \varepsilon^{\delta}$ and therefore that $\delta = \log_{\epsilon} \frac{I_1}{I_2}$. The quickest method of understanding the meaning of curves is to draw a large number of them.

WORK AND ENERGY.

WORK.

Work is done when the point at which a force is applied is displaced in the direction in which the force is acting; it is measured by the product of the force and the displacement. This product is *not a vector product*, because only the respective *magnitudes* of the force and displacement are multiplied. Fig. 23 represents a case where a point, P, is displaced by a force, F, from P to P^1, a distance d. **The work done by the force F is F × d.**

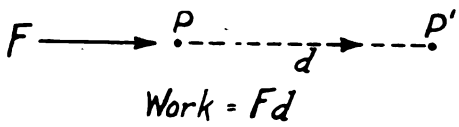

FIG. 23.

If the point is displaced in a direction other than that of the applied force the work done is measured by the product of the magnitudes of F and d and the cosine of the angle between the two directions. Fig. 24 will make this clearer. The force F is here acting in an easterly direction, and P is displaced to P^1, a distance d in a NE direction. The work done is the product of F, d, and cos θ, F and d being magnitudes only.

Work done by F = Fd cos θ.—This product is the *scalar product of two vectors.* Note that when $\theta = 90°$—that is, when the two directions are mutually at right angles—the work done is zero because cos $90° = 0$. This point throws light upon the fact that if a weight is carried along level ground no work is done *against gravity*, because the direction of the displacement is at right angles to that of the force supporting the weight.

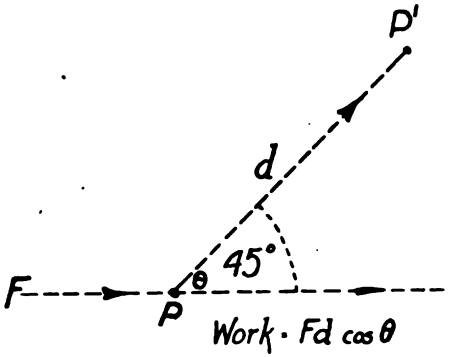

FIG. 24.

The student is strongly advised to act upon the hint that if he will go deeper into this matter of the scalar products of vectors and of *vector* products he will discover plenty of work which bears directly upon the electrical and magnetic phenomena in which he is interested.

Units of Work.—When unit force produces unit displacement unit work is done. Work being the product of force and displacement, the **dimensional unit of work** is:

$$\left[\frac{ML}{T^2}\right] \times [L] = \text{Force} \times \text{Displacement} = \left[\frac{ML^2}{T^2}\right] = [ML^2T^{-2}]$$

When a force of one pound acts through a distance of one foot the work done is one **foot-pound,** which is called the **Gravitational Unit of Work.** The work performed in lifting a weight of half a hundredweight to a height of a yard is therefore

$$\text{Weight (in lbs.)} \times \text{height (in feet)} = 56 \times 3 = 168 \text{ foot-pounds.}$$

When a force of one poundal acts through a distance of one foot the work done is one foot-poundal; this is the **British absolute unit of work.**

The C.G.S. absolute unit of work is that which is done when a force of one dyne acts through a distance of one centimetre, and is called the **Erg.**

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The practical electrical unit of work is the Joule, and is the work done in one second by a current of one ampere at a pressure of one volt.

1 joule = 10^7 ergs.

From the definition of the joule given above it will be seen that the work done when a current flows in a conductor equals ($E_{volts} \times C_{amperes} \times T_{secs.}$) joules, where T is the time during which the current is maintained. If $E = 1$ volt, $C = 1$ ampere, and $T = 3{,}600$ secs., the amount of work done is given the name of **watt-hour.** One thousand watt-hours are equal to one **kilowatt-hour,** sometimes called the **Board of Trade unit** or the **kelvin.**

Area of Work Diagram.—In Fig. 25 the line F represents a force of 2 pounds, and the line D represents the distance through which that force acts, in this case 2 ft. Since Work $= F \times D$ the work done in this instance is $(2 \times 2) = 4$ foot-lb.; but the product FD is clearly the area of the figure, so that if we draw a diagram the ordinates of which represent the force, while the abscissæ represent the displacement, then the area of the figure represents the work done. All the ordinates in Fig. 25 are equal because ab is perpendicular to F, and this means that

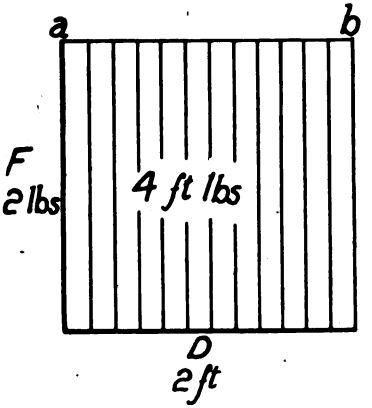

FIG. 25.

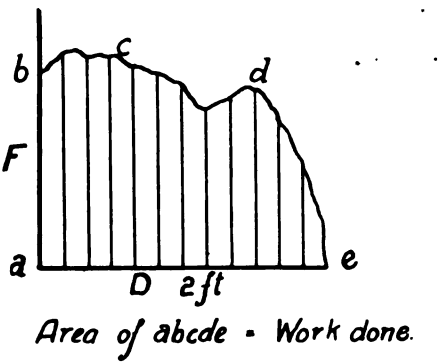

FIG. 26.

throughout the whole displacement the force is uniform. Fig. 26 shows graphically an example of a non-uniform force acting through 2 ft., and the height of the ordinate above any point on D represents the force at that point, *in the units of the scale to which F is drawn.* The area of the figure is in this case also the work done, but is not found so readily as in the case of an uniform force. Nevertheless the methods of finding the area of an irregular diagram are quite easy to learn and the student should supplement his knowledge at this stage by reference to his mathematical text-books; let him turn to **Simpson's Rule** and the **Mid-ordinate Rule** and practise them, for he is here assured that the work is quite relevant to his future studies in electricity.

POWER.

Thus far we have not taken into account, save in the special case of the joule, the amount of *time* needed to effect a displacement. Such a consideration is of the greatest importance, as will be readily understood if it is pointed out that the force F referred to in connection with Fig. 25 may require to act for a second in order to bring about the displacement D, or, on the other hand, it may require a week. The work done is precisely the same in each case but it is very evident that there is a big difference of some sort between the two performances, for the rate at which the work is done is enormously greater in one than in the other

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Even if a force does useful work it uses up equally valuable time and therefore it is highly necessary to have some measure of the amount of work a force can do in a given time. **The rate at which work is done is called power. The British unit of power** is the **horse-power,** and is equivalent to a rate of 550 ft.-lb. per second or 33,000 ft.-lb. per minute.

$$\text{H.P.} = \frac{\text{Work in ft.-lb. per sec.}}{550}$$

The C.G.S. unit of power is the rate of **1 erg per second. The practical electrical unit of power is the watt.** One watt is equivalent to 10^7 ergs (or 1 joule) per second, or $\frac{1}{746}$ horse-power.

Power in watts $= E \times C \times T$, T being 1 second. A larger unit of power is the **kilowatt,** in terms of which the power of wireless telegraph transmitters is usually expressed. Thus the well-known 1½-kilowatt wireless transmitter installed on so many merchant ships might be called a 1,500-watt installation.

Power and Work in A.C. Circuit.—The equation, Power $= E \times C$, refers only to a direct current. For an alternating current,

$$\text{Power} = E \times C \times \cos \phi,$$

ϕ being the angle of lag. If a power curve be plotted for an alternating current, with various values of $E \times C$ as ordinates, the *times* being abscissæ, the *area* of the curve will represent the work done by the current; but if the current is not in phase portions of the total area are *positive* and other portions are *negative*—that is, they are respectively above and below the base line along which time is measured, which means that the generator is alternately *giving out* and *absorbing* power. The difference between the total positive area and the total negative area for a period gives the total work done during that period.

An Echo from the Past

MR. GODFREY ISAACS, in the course of his address to shareholders at the Cannon Street Hotel, a full report of which will be found on pages 300 to 302, referred to the achievements of wireless telegraphy and the progress that had been made in the twenty odd years of Mr. Marconi's labours. This reference on the part of the Managing Director of the Marconi International Company brought forth a reminiscence from a Member of Parliament which appeared in the pages of *Town Topics*, and is worth recording here:—

"It is just twenty years ago since Mr. Marconi, now Senatore Marconi, gave "an exhibition of his wireless invention to members of the House of Commons. "He wanted to prove that a wireless message could be sent from the Terrace to St. "Thomas's Hospital, some three or four hundred yards across the river, and members "flocked to the Terrace to witness the experiment. There were considerable doubts "as to the result. John Burns busied himself in the arrangement of the small instru- "ment in one of the passages leading to the Terrace, and in fixing, to Mr. Marconi's "instructions, the eight- or ten-foot pole that stood against the Terrace wall some "thirty feet from the instrument.

"When arrangements were completed, Mr. Marconi invited the writer of these "notes to send any message he liked to the party in charge of the machine at the "hospital.

"At that moment the news came in that Gladstone had died, and the message "transmitted recorded that fact, and added a few words about the great statesman. "The instrument was set to work, and scarcely had the words been tapped off "when acknowledgment was announced from the other side. Hearty cheers were "given for the great inventor, but still there were some present who doubted whether "the invention would ever be of any practical use."

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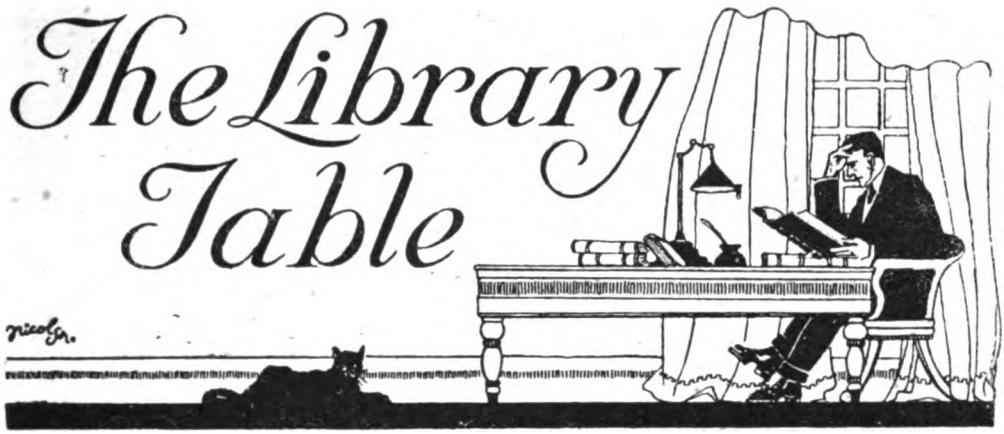
The Library Table



MATHEMATICS FOR ENGINEERS. By W. N. Rose. London: Chapman & Hall. 8s. 6d. net.

The modern tendency to specialise is increasingly reflected in the publication of textbooks. Thus, happily, we no longer see the bulky tome endeavouring to cover every branch of the subject, and failing both by reasons of the limitations of the author's knowledge and the meagre treatment of individual parts. To such have succeeded the smaller volumes, devoted to a single phase of the subject and written with expert knowledge of that phase. It is in this category that we must place the book before us.

Although this is by no means the first book to specialise in Engineering Mathematics, it is nevertheless designed to fill a gap the existence of which has been obvious for some time past. Most books deal with this important science either from a strictly theoretical standpoint, bearing little relation to everyday practice, or else err in the other direction, by offering the facts without reasonable explanation of principles.

In the words of the author, "An endeavour has here been made to produce a treatise so thorough and complete that it shall embrace all the mathematical work needed by engineers in their practice, and by students in all branches of engineering science." This, it will be granted, is an ambitious aim, and one inviting criticism which might otherwise be withheld. Let us say at once, however, that the author appears to have carried out his work in a very thorough fashion, keeping always before him the daily work of the engineer.

In the compass of one volume it is impossible to bring together everything needed, and therefore a second is announced as shortly to appear, completing the subject. The work is divided so that in part one the fundamental rules and processes of Algebra are dealt with, as are those of Plane Trigonometry, Mensuration, and Graphs; while in part two the Calculus and its applications, Harmonic and Vector Analysis, and Spherical Trigonometry will come in for treatment. The "Directly Useful" textbooks, of which this is the latest to appear, has already established itself firmly in public favour, and we can foresee a steady sale for this book, as for the other volumes of the series.

* * * * * *

HUNS IN PALESTINE. By L. de Sousa. Andrew Melrose, 3 York Street, Covent Garden, London. 5s. net.

The British expeditions to Mesopotamia and Palestine, their fluctuations in fortune and ultimate success, have recalled popular attention to those ancient

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lands. The situation in the civilised world, during the period of history covered by the books of the Old Testament, may be briefly summarised as follows: On the North lay Assyria, pre-eminently the great Military Empire. On the South stretched the land of Egypt; and civilisation (as it existed then) found a safe and congenial home in the lands fertilised by the beneficent waters of the Nile. The latter was simultaneously the country of mystery and enlightenment; the problem of the mighty river with its unknown sources exercised the thinking powers and imaginative speculation of explorers and men of letters in those days, as it continued to do until the secret yielded to the indomitable courage of the nineteenth-century explorers. In Arts and Sciences, the Egyptians obtained such a lead as to form the source of inspiration for the whole ancient world. To them the Assyrians owed their sculpture, the Greeks their architecture and painting, the Romans their methods of government and administration. Between these two great Powers stretched the small country of Palestine; dominated, though not entirely peopled, by the Jewish branch of the Semitic race. The kingdoms of David and Solomon occupied the position of what we call a "Buffer State," now inclining on the one side, now on the other; but managed to maintain their independence so long as Israel and Judah held together. The separation proved fatal.

Mr. de Sousa has chosen for the scene of his drama that point in history when the Prophet Isaiah had stirred the religious enthusiasm of his co-patriots, and when Hezekiah had succeeded in moulding Jewish enthusiasm into a concrete shape. The Military Power of Egypt was at low tide, that of Assyria on the flood. Those were the days when even patriotic Jewish writers were forced by the logic of events to speak of "The Great King, the King of Assyria." Sennacherib, to quote the words of Byron, "came down like the Wolf on the Fold." Hezekiah, listening first to the partisans of the Northern Kingdom, attempted to avert the storm by sending tribute. The Assyrians accepted the tribute and then proceeded to invest Jerusalem. What happened then we do not know *historically*, but legend has been busy and our novelist devotes some striking passages to the traditional episodes. The siege terminated in a disaster to the Assyrian arms, and the rest of Sennacherib's career was dogged with misfortune, until his subjects ended it by revolt and assassination.

Such is the story told us by the author of *Huns in Palestine*, who has clothed his narrative with more than ordinary skill, utilising the traditional material of Love, Ambition, and War. A beautiful daughter of Hezekiah—Nehushta is her name—furnishes the love; Shebna, Hezekiah's treacherous Minister, the ambition; and Amon, Prince of the tribe of David, the war. The local colour has been extremely carefully laid on, and we congratulate Mr. de Sousa on the way in which he has managed to convey the "atmosphere" of bygone ages. We can assure readers that a true breath of Eastern air pervades the incidents throughout.

History repeats itself, and the title *Huns in Palestine* not unjustly recalls the present situation, when the spirit of freedom and independence is struggling for delivery from the withering influence of military dominance. Moral degradation combined with physical strength; infamous treachery allied to skilful scheming; self-complacency wedded to utter contempt of the rights of others, characterised the Assyrians of this far-off period, as they characterise the Germans of to-day.

Share Market Report

London, July 17th, 1918.

DEALINGS in the shares of the Marconi Group have been very active during the past month. The issue of the report for 1917 of the parent company was extremely favourably received, and has brought in considerable investment buying of the shares of the various issues. The prices are very firm as we go to press. Marconi Ordinary, £3 16s. 3d.; Marconi Preference, £3 5s. 0d.; American Marconi, £1 5s. 0d. (*ex. D.*); Spanish and General Trust, 11s.; Canadian Marconi, 12s.; Marconi International Marine, £2 16s. 3d. (*ex. D.*).

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Personal Notes

Awards.

Mr. J. I. de Wardt, one of the principal officials attached to the Secretary's Office at the G.P.O., was included in the recent Honours List as recipient of the title of *Officer of the Order of the British Empire*. Mr. de Wardt has been for many years interested in Wireless Telegraphy and is well known to a number of our subscribers. We tender him our hearty congratulations both on our own behalf and that of our readers. It is highly gratifying to note this official recognition of his services, and we take this opportunity of expressing a hope that he has a long and honoured career in front of him. We may say that to his courtesy The Wireless World is indebted for the personal particulars relating to the late Mr. E. W. Farnall which appeared in our June issue.

Sergeant H. Squelch, Wireless Section, R.E., who a few weeks ago was made a King's Sergeant, is now the recipient of the D.C.M. Prior to the outbreak of hostilities Sergeant Squelch was on the postal staff at Chislehurst. He enlisted in the Royal West Kents in September, 1914, and served overseas with that regiment, subsequently being transferred to the Wireless Section, R.E.

For Meritorious Services.

Operator William Crossley Bowey, whose name (inadvertently given as C. Bovey) appeared in the list published last month of those to whom grants have been made by the "Ships' Gratuity Committee," has received high commendation from the captain and chief engineer of the ship on which he was senior operator for his praiseworthy conduct on the occasion when she was torpedoed. The captain was trying to save the vessel by running her aground, and had ordered port and starboard lifeboats away, when Mr. Bowey, who had done all that was possible in connection with his wireless duty, volunteered to stay with the captain and assist him in case the ship foundered.

Mr. W. C. Bowey

The aerial wire had by this time become damaged, but at the captain's request further efforts were made to radiate distress signals by Mr. Bowey, who then stood by the bridge to render whatever assistance might be possible and in any way that he could.

When the captain's efforts to ground the ship were successful, and both anchors let go, Mr. Bowey went below and conveyed the message to stop the engine.

In Hospital.

One of the participants in the Jutland battle, and latterly on submarine duties, Wireless Operator Herbert Brooke, of Mirfield, Yorks, is at present in the Royal Naval Hospital, Gosport, suffering from the effects of an accident.

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MEMORIAL.

Crowds of people assembled in front of S. Peter's Old Collegiate Church, Wolverhampton, on Sunday, June 23rd, to witness the unveiling of the bust of DOUGLAS MORRIS HARRIS, A.B., R.N.V.R., the heroic wireless telegraphist on board the drifter *Floandi*, who, while the enemy was shelling the vessel, continued to send messages and only ceased to do so when killed. He fell dead over his log-book while writing. The monument was unveiled by Vice-Admiral and Major-General Mark Kerr, C.B., M.V.O., and bears the following inscription :

" Douglas Morris Harris, A.B., R.N.V.R., the heroic wireless operator who continued to record messages in the log-book on the shell-torn drifter *Floandi* until killed by enemy gunfire, Adriatic Sea, May 15th, 1917."

Photographs of Telegraphist Harris and the mutilated log-book were published in our issue of September, 1917, pp. 398, 399 and 414. The block which accompanies this page shows the statue just unveiled, whilst that on page 279 depicts the unveiling ceremony.

STATUE ERECTED IN MEMORY OF OPERATOR D. M. HARRIS

OBITUARY.

The death of MR. P. H. JOHNSON, which occurred on June 6th, came as a shock to his many friends, and deep sympathy is felt for his family in their bereavement.

Mr. Johnson, who joined the Marconi Company's Operating Staff in 1903, returned from Callao last year, where he had spent four years in the capacity of Resident Inspector, and since had been attached to the Traffic Manager's Department, Marconi House, taking duty up to within a few days of his death. Having been in indifferent health for some time past, he underwent an operation medically advised, but unfortunately, although this was successfully performed, did not rally. The funeral took place on June 12th, at Woolwich Cemetery, the Rev. J. Wilson, uncle of the deceased, conducting the simple service held in the cemetery chapel, at which the Traffic Manager was represented. Many relatives and friends attended to pay a last tribute, the numerous and beautiful wreaths which were placed on the grave (including one from the Marconi International Marine Communication Company, Limited) testifying to the esteem and affection in which he was remembered by all with whom he was associated.

We regret to announce the death of LIEUT.-COLONEL DOUGLAS HYDE HYDE-THOMSON, aged 27, who was killed while flying over Kent on May 21st. He first served in the Royal Navy, attaining the rank of Lieutenant, and joined the Royal Naval Air Force in 1914, being connected with the early experimental work of that arm. His energies had latterly been devoted to matters electrical, mainly wireless telegraphy, and his loss will be greatly felt in this branch of service.

News that Air Mechanic and WIRELESS OPERATOR JACK COLINSKY has died of wounds received in action has been received with much regret. An artist, and previously on the staff of the *Daily Sketch*, he joined the Royal Flying Corps in 1916.

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Wireless Workers in a Good Cause.

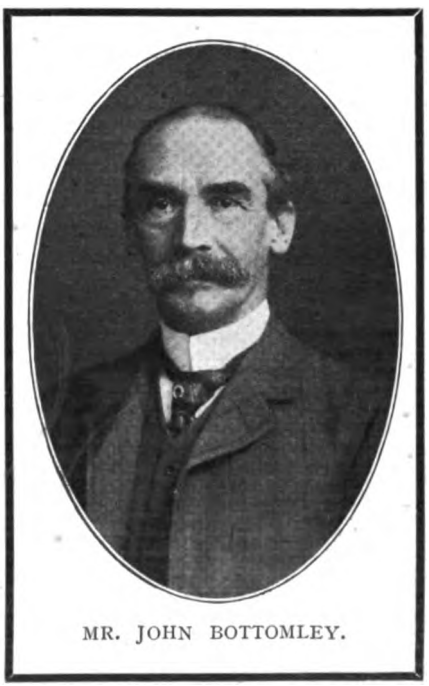
On June 7th last was held what is known as "Salvation Army Flag Day," when that well-known institution endeavoured to get together a substantial sum of money for expenditure on huts and ambulances in France. The lady workers at Marconi House undertook to help the cause, and so effectively did the 60 girls composing this little wireless army work that no less a total than £150 was handed over to the Central Fund. This amount, so the Salvation Army authorities inform us, constitutes a record for any depot in London, either this year or last year.

The district covered ranged from Chancery Lane to Wellington Street; about 26,000 flags were disposed of, and the multitude of the small offerings which made up this creditable total may be gauged from the fact that it took two strong men to carry the coin after it had been bagged. Mrs. Bramwell Booth and her daughter, Miss Mary Booth, O.B.E., called personally to express their gratitude, and desire that each worker should be individually thanked for her exertions.

In Memoriam

Of a strenuous life devoted to Radiotelegraphic Progress

On Sunday, June 16th, Mr. John Bottomley, Vice-President of the Marconi Wireless Telegraph Company of America, passed away at his private residence in New York City, in the seventieth year of his age. Mr. Bottomley was sprung from a good old Irish family located in the "Black North," and first saw the light at Belfast in 1848. He was justifiably proud of his origin, and more particularly of the fact that he could claim the relationship of a nephew to the late Lord Kelvin. His education was conducted at Queen's College, and he started in life by engaging in the British export trade, first crossing the water to New York in 1880. Once over "on the other side" he devoted his energies to the study of law and practised extensively in that profession until 1898, when his imagination was fired by the discoveries in radiotelegraphy of Senatore Marconi. Mr. Bottomley, full of enthusiasm for the new science, undertook the task of introducing it to the American world of commerce. Four years subsequently he became General Manager, Secretary and Treasurer of the Marconi Wireless Telegraph Company of America, and successfully guided the Company through its early struggles. The welfare of the Company and the advancement of radiotelegraphy were "as the breath of his nostrils" and he died, as he lived, in harness. He took a very keen interest in the human side of the corporation and was ever ready with a helping hand to the younger members, finding time, moreover, out of a busy life, for engaging actively in church and social work. His death removes a notable figure from the world of American Wireless, and leaves a gap which will never be filled in the business and social life of his colleagues.



MR. JOHN BOTTOMLEY.

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Company Notes

Marconi International Marine Communication Company, Ltd.

Continued Development of the Business

A "Very Important National Service."

THE 18th Ordinary General Meeting of the Marconi International Marine Communication Company (Ltd.) was held on Tuesday, July 2nd, at the Cannon Street Hotel, Mr. Godfrey Charles Isaacs, the Managing Director, presiding.

The Secretary (Mr. Henry W. Allen, F.C.I.S.) having read the notice calling the meeting and the Auditors' report,

The Chairman said:—Ladies and gentlemen,—I had hoped yesterday that our illustrious Chairman, Senatore Marconi, who arrived in London on Sunday night, would have been able to preside at this meeting to-day. He has, however, come here as the head of the Italian Mission for the International Commercial Conference; his duties commenced to-day, and they will detain him during the whole of this meeting. In those circumstances he asked me to excuse him to you and to preside at the meeting in his place. The report and balance-sheet are before you, and I propose to adopt the usual course of taking them as read, and proceed at once to deal with the figures in the accounts before touching upon other matters.

Balance-Sheet Changes.

If you will look to your balance-sheet, you will find the increase in the capital of the Company from £350,000, as it stood at the end of 1916, to £600,000 at the end of 1917. The whole of this capital was issued, and, but for a few pounds then outstanding, was entirely paid up by the end of the year. The Debentures have been reduced from £114,360 to £112,280 by purchases during the year. The general reserve account, which stood at £47,653 10s. at the end of 1916, has now been increased to £258,009 3s. There is an increase in the creditor balances arising very naturally from the greater volume of the Company's business. Upon the credit side "Plant, apparatus, furniture, and stores," which stood at £350,320 at the end of the preceding year, from which the usual substantial depreciation has been written off, nevertheless shows a very substantial increase, amounting to not less than £227,000. This, of course, represents the greatly increased number of stations installed on board ships during the year 1917. The next item shows but a trifling change. The debtor balances have increased by some £116,000, which, again, is due to the greater business; and our cash resources, both in regard to cash at bankers and investments in War Loans, and in short loans against securities, amounted together at the end of the year to some £410,000 in round figures, as compared with £75,000 at the end of 1916, the increase being accounted for in large part by the increase of capital and otherwise, of course, by the accumulation of profits.

The Profit and Loss Account: Largely Increased Receipts.

If you will turn to the profit and loss account, there are, under the several headings covering salaries, general charges, expenses, etc., merely such variations of figures as you would expect from the considerable development of the company's business. The amount of depreciation of plant and apparatus of £39,529 is shown separately, and is, I think you will agree, a substantial but nevertheless a reasonable, sum. The receipts from ships' telegrams, subsidies, etc., have increased from £270,000 to £470,000; and the profit carried to balance-sheet amounts to £192,000, as compared with £96,000 in the preceding year. I should point out to you here that the increase in the profit is due entirely to increase in the volume of the business. In the appropriation account there figures the 5 per cent. interim dividend declared at the end of last year and paid on February 1st, and, as you will see, we propose, subject to your approval, to declare a further dividend of 10 per cent., which will absorb a further £60,000. We are placing £50,000 to reserve for obsolescence of plant—a course which we think necessary, for, when this war is over, we shall require to replace a great many of our ship stations by stations of new design, which it has been impossible for us to do during the war, and which, in fact, we cannot attempt even now, for the urgent need of equipping ships with wireless installations is so great that we must continue to manufacture as fast as we can of the design with which those employed in the work of manufacture are used, and, therefore, can most quickly produce. We have good reason to believe that due and proper consideration will be given to this question in dealing with the question of excess profits. We propose to carry forward the sum of £105,417 19s., subject, of course, to the excess profits duty for the years 1916 and 1917, when these amounts are finally agreed. I do not think that there is anything more in the accounts which calls for comment or information, and you will, I am sure, agree with me that we have every reason to be well satisfied with the business of the past year, particularly when it is borne in mind that our telegraph business on board ship is reduced to the extreme minimum in consequence of the necessary restrictions arising from the state of war.

The Increase in the Capital.

It will also be borne in mind that for the reasons which we explained in our circular last year it

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became necessary for us, in order to meet the obligations which we had undertaken with the Board of Trade to provide for installations on board a large number of additional vessels, to increase the capital of the Company to £600,000. It will be remembered that this increase of capital took place towards the end of the year, and therefore for the year under review we had practically no benefit from this increase of capital, but we are nevertheless paying the dividend upon the increased amount of £600,000 instead of £350,000, the amount of the capital in the previous year. We offered, as you know, this increase of capital to our shareholders on terms which we thought would be sufficiently tempting to them, and I am very glad to be able to say that the whole of the amount was taken up by shareholders; in fact, it was considerably oversubscribed, and I think they have every reason to congratulate themselves that they did avail themselves of our offer. Not only will they have received, if shareholders endorse the Directors' recommendation this afternoon, a dividend of 15 per cent. upon the shares for which they subscribed late in the year, but they have, I think, a very sound and improving security, with the very substantial profit of about 20s. per share attached to their investment.

The Company's Stations: The Total Rentals.

By the end of the year, as we have told you in our report, the total number of public telegraph stations owned and worked by the Company on the high seas had increased from 1,472 at the end of December, 1916, to 2,265. But these figures really do not give you any precise indication of the number of ships fitted during the period, which, as you can well imagine, was considerably more than the mere subtraction of the one figure from the other would suggest. For very obvious reasons I do not propose to tell you what the missing figure is, but you will all quite well appreciate that it was a very considerable one, and represented the number of ships with installations on board which were lost during the year. To the end of June, after making a similar deduction for ships lost during this year, the total number installed and, so far as we know, plying the seas was 2,446, showing a further substantial increase for the first six months of this year.

At the end of 1916 our total rentals were at the rate of £352,000 per annum; at the end of 1917 this figure had increased to £570,000 per annum, and at June 30th of this year they amount to £703,374. I do not think it is necessary for me to say more to indicate to you the continued satisfactory development and growth of our business.

Wireless Operators and their Pay.

It is probable that many of you have felt a little anxious in recent times as a result of the threatened strike of wireless operators in consequence of their being dissatisfied with their rate of pay. I therefore propose to say a word to you upon this subject in order that our position in this matter may be clearly understood by all. Firstly, I would explain to you that the contracts which we enter into with shipowners provide for the most part for a certain annual payment to be made to us in respect of operators' wages so long as the scale of pay continued as at the time of the contract. If an increase became necessary we had to agree with the shipowners before consenting, and whatever that increase amounted to had to be added to the sum paid to us by the shipowners to cover the further cost arising from such increased pay to the operators. You will therefore see at once that in so far as we are concerned we are unable to deal with any question of increased pay without the agreement of shipowners, unless we choose to accept the responsibility of it ourselves, and for our own account. This is not contemplated under the terms of our agreements with shipowners. We did, however, think well at the end of last year, in consequence of the great increase in the volume of our business, and the consequent spreading of standing charges, to give an all-round increase of 5s. per week, which entailed a considerable burden upon the Company, but beyond that we could not go.

Improved Terms of Employment.

As a result of the very much increased rates of pay to the mercantile marine, given under directions of the Ministry of Shipping to all seafaring men, the wages of the operators no longer seemed adequate, and application was accordingly made to the Ministry of Shipping to agree to the increase demanded by the Association of Wireless Telegraphists. Inasmuch as the Ministry of Shipping was, I understand, so fully occupied with other questions, this matter was deferred longer than the operators felt it should have been, and therefore the threat to strike. The Company, however, have had the opportunity of conferring with the representatives of the Association of Wireless Telegraphists, and in so far as all matters touching the conditions of employment by the Company are concerned a complete agreement was arrived at. A new scale of pay was also considered, and the Company recommended its acceptance to the Shipping Federation and to the Ministry of Shipping. I am glad to be able to say that the Shipping Federation have recognised the recommendation as reasonable, and, subject to argeement with the Ministry of Shipping, the new terms will be put into operation.

What I particularly wish to point out is that, although operators are employed by the Company and paid by them, their remuneration is provided by an agreed subsidy from the shipping company. Your Directors have been glad to recommend the improved terms of employment of operators, for their conduct as a body has been magnificent during these very perilous times. No praise of them could be too high. I am sorry that public interests do not admit of my publishing at the moment innumerable instances of their great courage and self-sacrifice. One day, however, their brave deeds will be recorded, and it will then be generally recognised what great services to their country and to the general public have been rendered by these young men, popularly known on board ship by the name of "Sparks."

Heroism of Wireless Operators.

I could not refrain last year from giving you one or two examples of how they acted in moments of peril; since then one could write volumes upon their heroic conduct. I must relate to you one case, however, illustrative of so many more, to help you to appreciate the material of which this body of men is composed. During the latter part of last year a ship (I must not mention her name) was some 140 miles from the coast when she was attacked by a submarine, which launched a torpedo at her. Fortunately the torpedo passed under the ship without doing any damage. Very soon afterwards the submarine appeared on the surface at a distance of about four miles and commenced to shell the ship. This continued for about an hour, during which period the operator remained in his cabin and got into communication with a land station, from which he was promised the immediate assistance of a destroyer. During the

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whole hour the ship was being shelled the operator remained at his post in the hope of getting into touch with a ship which would be able to give earlier help. The captain sent a message by the first mate to the operator to the effect that, having obtained communication with the coast and the promise of assistance, it was advisable that he should leave his post, which was in a most exposed position, and take shelter. The operator replied that he was getting into touch with an American light cruiser, which he believed was nearer than the British destroyer, and was therefore likely to give earlier assistance; meantime he could not leave his cabin. As soon as he was able to get his message through to the ship and obtain a satisfactory reply he would take shelter. Within a few moments the submarine abandoned solid shell for shrapnel, and fired a shot which passed directly through the cabin, decapitating the wireless operator. When the captain and officers went later to the wireless cabin they found his headless body sitting in the chair, with the completed message from the American cruiser in front of him. Only the timely arrival of the American vessel prevented the ship from being sunk.

This story, you will agree, is a very sad one, but the outstanding feature of it is this. Had the operator left his cabin, as he was authorised by the captain to do, the ship would probably have been sunk, and it is more than likely that many, if not all, on board would have been lost, but by remaining at his post he obtained the assistance of the nearer ship, and, to use the words of the captain and the officers, "his plucky action in sticking to his post was undoubtedly the means of saving the ship, its officers, and crew, numbering in all 45 souls." This is an example of the conduct of wireless operators on board ships of the mercantile marine. It is a very sad case, and I am glad to say that many who have acted equally bravely have been more fortunate, although, as our report tells you, the list of those who have lost their lives in the past year is again a considerable one. Rewards for bravery in the field have been given, no doubt most deservedly, to a very large number, but, however well-deserved they may have been, I do not think there could be cases of greater bravery and devotion to duty than such a case as I have related (which is only one of a great many), and I trust that due recognition will be given by the authorities to the brave acts of wireless operators as well as to those who have served their country on other fields of battle. (Hear, hear.)

What the Company has Done.

It must be a matter of considerable satisfaction to those shareholders who originally invested their money in this Company, to the Directors who were associated with it many years before I became connected with it, and particularly to our illustrious chairman, Senatore Marconi, to see not only the great and successful development of the Company's business, but also the immense service which the Company, through its world-wide organisation, has been able to render in these anxious and perilous years to the Empire, the Allies, and the peoples of every neutral nation. It is impossible to estimate how many tens or hundreds of thousands of lives have been saved or safeguarded, and it is difficult to say, even approximately, how many millions in pounds sterling of invaluable material and food supplies have been saved and brought to our shores. Primarily, of course, we owe our thanks to our wonderful Fleet, but the Fleet behind the Fleet (as the mercantile marine has been so aptly termed) has also played a great part, to which this Company, its vast organisation, and its splendid staff of wireless operators has very largely contributed. Yet it is but comparatively few years ago—not more than ten—that the Company was installing ships with wireless stations free of cost in order to demonstrate that a wireless telegraph station on board ship could really serve a valuable and useful purpose, and over £100,000 of shareholders' money was expended to convince the public of the great and valuable thing Senatore Marconi, through this Company, was offering to them.

The Value of One Control and Organisation.

Before the war there was a disposition amongst some in this country to complain of what was regarded as something in the nature of a monopoly which this Company possessed. I frequently had occasion to point out how essential it was, to my mind, that a business of this nature should be under one control, one organisation; and if this war has proved anything, it certainly has, I think, demonstrated beyond all question how fortunate and how helpful one control, one organisation, dealing with the whole of wireless telegraphy upon our mercantile marine, has been. Had this business been divided up amongst a number of companies, I think it would have been imperative for the Government to have commandeered them all and brought them under yet one more Government Department. Fortunately, the whole of the business was in the hands of the Marconi International Marine Communication Company (Ltd.); there was an excellent organisation, perfect discipline, and one control—in a word, there was efficiency.

Only those who are interested in, or who are connected with, this Company hear anything about the work it does; the general public hear nothing, and this is explained, to my mind, simply by that one word "efficiency." With inspectors, repair shops, and stores in practically every port of importance throughout the whole world, the 4,000 wireless ship stations managed by this Company and its associated Companies have been thoroughly maintained and in effective operation from the day war was declared.

It was with no small satisfaction that every man in this Company hailed the honour of Commander of the Order of the British Empire bestowed upon our manager, Mr. W. W. Bradfield, by his Majesty the King. (Cheers.)

A great debt of gratitude is owed to him, to Mr. Allen, our Secretary, Captain Daly, Mr. Turnbull, Mr. Cross, Mr. Lewis, to the other officials of the Company, and to the whole of the staff of the Company, not only by the shareholders, but, in my view, by the peoples of the Empire, the Allies, and the neutral countries, for the indefatigable energy they have bestowed upon the very efficient maintenance of this very important national service; and in this connection we must not forget the Italian branch of our business, which has been equally efficiently managed by our representative in Italy, the Marquis Solari.

The Chairman then proceeded to explain the purport of some proposed alterations in the Articles of Association. He moved the adoption of the Report and Balance Sheet, and the resolution—after being seconded by Mr. Alfonso Marconi—was carried unanimously.

The retiring Directors were re-elected and a resolution increasing the fees of members of the Board was put and carried.

An Extraordinary General Meeting followed, at which the alterations in the Articles of Association explained by the Chairman in his address to the shareholders were carried, and the proceedings concluded with a vote of thanks to the Chairman, Directors and Officers of the Company.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly.* (3) *Queries should be as clear and concise as possible.* (4) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers.* (5) *The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

J. B. G. (Huddersfield) asks for "full particulars" about the Wireless Section of the Mercantile Marine. As we have dealt with this subject on many previous occasions, we can only refer our correspondent to back numbers, particularly the January, 1917, issue. There is one point of importance, however, which we should like to indicate. *No student should commence the study of wireless telegraphy with a view to becoming a wireless operator in the Mercantile Marine if he is older than 17 years and 3 months.* Save in the case of men who commenced their studies prior to April last, exemptions will no longer be granted to students after they reach the age of 18 unless they obtain their certificates and employment as operators on board ship before that date. Many men complete their course in six months, but nine should be allowed in order to be on the safe side.

F. F. (Hull).—(1) The present demand for operators is fast being supplied from men already in training. We cannot say what future requirements may be. Certainly those men who did not avail themselves of the Marconi Free Training Scheme (now closed) missed a golden opportunity. (2) Yes, the men are taken for permanent positions. (3) Physical fitness and general suitability for sea life. (4) This depends on circumstances. Many men have taken charge after one trip as junior. (5) Operators are promoted to higher positions as vacancies arise. Depot Superintendents are invariably promoted from the ranks of the senior inspectors, and in order to qualify for these latter posts it is necessary to pass an examination. Vacancies for Depot Superintendents do not often arise, as the number of such posts is limited.

"VALVE" (Cornwall).—It is highly improbable that a man would be released from the R.N.V.R. or other branch of His Majesty's Service in order to take up such a position as you mention. It would be necessary for you to wait for your discharge in the ordinary way.

D. J. F. (Carrick-on-Suir) asks (1) "What is the maximum voltage developed in the secondary circuit of a Marconi 10 in. coil to the primary of which 25 volts pressure is applied?"

Answer.—With the hammerbreak well adjusted the coil will give a stream of sparks between its two secondary terminals with the discharge balls removed. Every coil has to pass this test before leaving the works. It is difficult to give the exact voltage as no two authorities seem to agree on what voltage is required to give a 10 in. spark between points. Very approximately the voltage may be called 100,000. (2) The greater the amplitude of the wave the greater the effect produced. (3) An intermittent unidirectional current, the pulses of current being equal in frequency to the sets of waves, or "wave trains," received on the aerial. The current is not oscillatory as it has been rectified into pulses by the detector. (4) From the way you put this last question it is evident that you do not understand the principles of transformation. We would advise you to study this subject in *The Elementary Principles of Wireless Telegraphy* which you possess. Turn up pages 80 and following in Part II.

J. E. J. (Lowestoft).—Are the leads from the dynamo cased in lead? If so, make sure that the casing is earthed. If this is ineffective try earthing one of the terminals of the telephones.

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This is sometimes but not always effective. The dynamo brushes may also be sparking—a frequent cause of trouble. Keep the coupling of the receiver as weak as you can without unduly reducing the strength of signals. Please note that we cannot deal with queries through the post.

W. A. B. (Castleford).—On breaking the circuit the current of self-induction charges the base condenser, which promptly discharges through the primary and completes its demagnetisation. Its main purpose is to increase the suddenness of the break. Is this the information you require?

W. S. (Blackheath).—As stated above, the Marconi Free Training Scheme is closed. (2) *Electricity and Magnetism for Home Study*, by H. E. Penrose (see our advertising columns). (3) Not to the best of our knowledge. It merely shortens his period of training in the R.N.V.R.

Many thanks to the correspondent in Edinburgh who sends us an account of his experiences with a postal course. In his opinion, the time at the practical work is very little shortened by taking a correspondence course—not sufficient, he says, to justify taking one. Perhaps some other readers have been more fortunate.

E. M. (Newport Pagnell).—Brick being to all intents and purposes an insulator (except when wet) there would be no practical difference between the two arrangements. In any case, the effective height would be from the *top* of the earth lead, any conductivity of the brick merely affording a parallel path to earth.

J. F. (Leek).—(1) Seventeen years and three months. (2) Yes, precisely the same. It does not matter whether a man is trained free by the Marconi Company or pays fees at a private school. When he is appointed to the staff he gets the standard rate of pay. (3) None in Staffordshire. In any case the free training scheme is closed. (4) *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, and the *Handbook of Technical Instruction*, by J. C. Hawkhead and H. M. Dowsett (see advertising columns). Thank you for your good wishes and appreciation.

L. J. W. (Shepherd's Bush).—You might take a course at one of the wireless colleges advertising in our magazine and apply for a position as soon as you obtain a First Class Certificate. If there are vacancies at that time your application will be given consideration. (2) This depends on the Army requirements at the moment. (3) The nearest recruiting office could give you this information better than we can. (4) Depends on yourself. If you have no knowledge of telegraphy you should reckon upon four to six months.

SAPPER J. H. G. (B.E.F.).—(1) The purpose of the high voltage battery is to supply the energy to the telephones. The small current in the "grid" circuit "triggers off" the larger current in the sheath circuit. (2) You cannot consider the electrons apart from the current. A flow of electrons can be looked upon as a positive current in the opposite direction. Electrons flowing from the filament to the sheath give the effect of an electric current from the sheath across the space to the filament. (3) No, not at present. We hope to publish some more shortly. Have you read all the recent valve articles in THE WIRELESS WORLD?

SPECIAL NOTE.

THE MARCONI FREE TRAINING SCHEME IS NOW CLOSED.

Correspondents who wish to train as Wireless Operators should apply to the nearest Wireless Training School or College.

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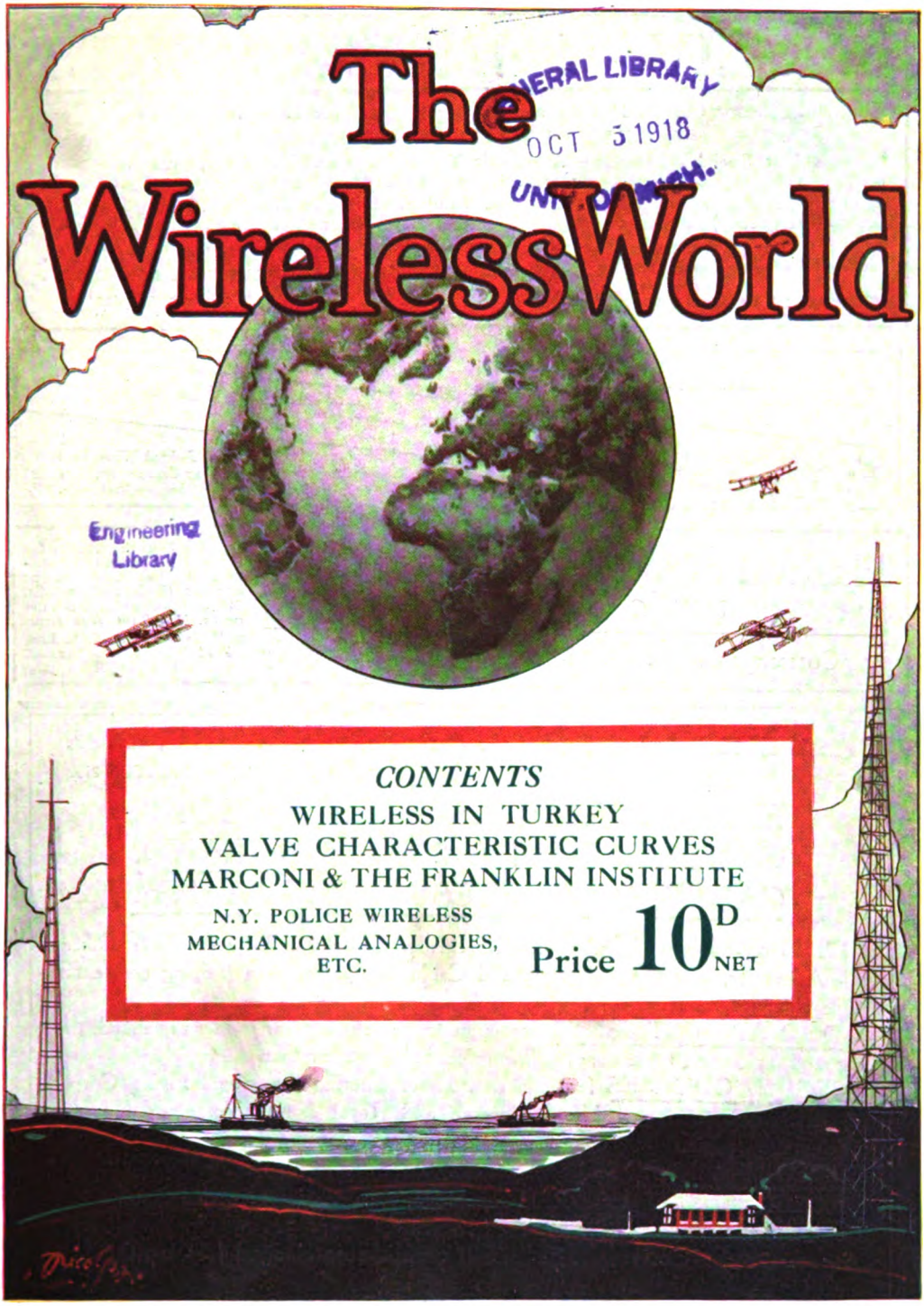

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Single copies, 10d. each, or post free 1s. 1d.

Articles submitted for acceptance by the Editor (which will be paid for on publication) should be addressed to Marconi House, Strand, London, W.C. *No responsibility can be taken for MSS. or Photographs sent without stamps to defray cost of return postage.*

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The
WIRELESS
·WORLD·

Volume VI. No. 66. SEPTEMBER, 1918.

Wireless in Turkey

An Amateur's Experiences

By W. GORDON CAMPBELL

THE wireless station at Constantinople was erected by the Marconi Company a few years before the present war and a description of the installation was given at the time in these pages. I may, however, mention here that the principal set has a power of 20 kilowatts, while a supplementary 3-kilowatt set is used for signalling over short distances. The aerial is of the " umbrella " type and the musical note emitted is of a peculiarly " plaintive " character. This station occupies a prominent position on an eminence overlooking the Golden Horn, known as " Ok Maidan " (arrow place), which indicates that the spot was formerly used as archery ground.

When the Marconi engineers were erecting the station and installing wireless on the Turkish warships I was myself connected with the Admiralty, and had a " teskere " or pass which enabled me to go where I pleased in the arsenal. I also had access to the wireless station. At the request of the British admiral, who then acted as adviser of the Minister of Marine, I was giving a course of advanced instruction in English to officers of the wireless department, who were afterwards to be sent to England to complete their technical studies at the Marconi works. The room at the arsenal in which I gave this instruction adjoined the store and workshop where Mr. W. Beale Cole, of the Marconi Company, was fitting up the apparatus to be used on the warships. It was natural, therefore, that we two Englishmen should foregather together in that foreign land, and it is to him that I am indebted for my first practical introduction to the mysteries of wireless.

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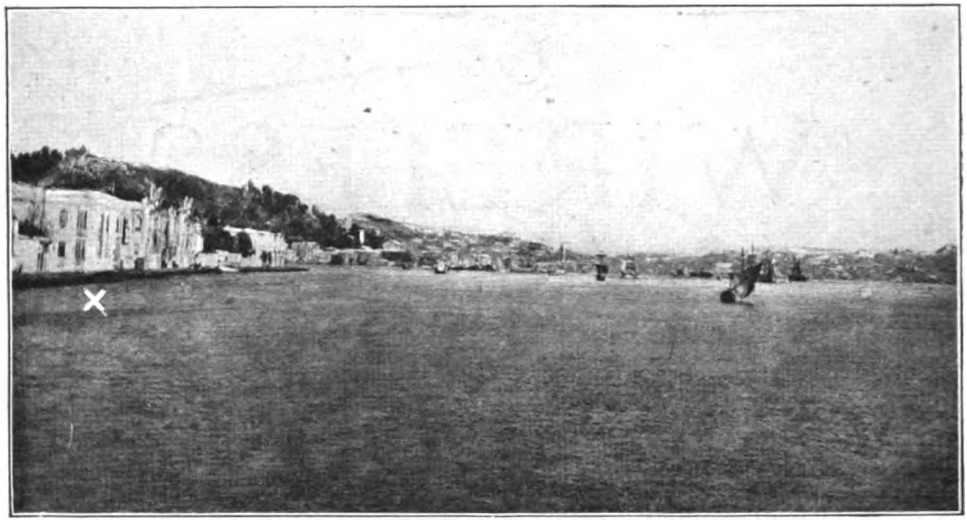

ENTRANCE TO THE BOSPHORUS: THE DOLMA BAGHCHEH PALACE, MARKED X, WAS THE LOCALE OF THE ASSASSINATION OF THE SULTAN ABDUL AZZIZ IN 1875.

Mr. Cole, besides being a skilled electrical engineer, has in latter days developed a literary faculty, and his name will be familiar to the reader as the author of several interesting semi-scientific tales and topographical articles contributed to this magazine.

Of the engineers occupied in installing the Ok Maidan station I came chiefly in contact with Mr. James and Mr. Strang. On one occasion I passed a whole night with them at the station and had an opportunity of seeing "how it works" under their able guidance. The Turkish officer in charge had been trained at the Chelmsford works and spoke English fluently.

Mr. Cole occupied a room on the fourth floor of an hotel in Pera, the European quarter, from the windows of which Ok Maidan was clearly visible at a distance of about two miles across the valley of Cassim Pasha. Communication was established between these two places at night by means of lights which flashed out the Morse signals. I was usually present during these conversations and then made my first attempts to master the Morse code. But that was by no means an easy task. I subsequently found, after trying various methods, that the most satisfactory was that adopted on the "Morse made easy" card issued by the *Wireless Press*, in which the long and short signals forming a letter are indicated by the accented and unaccented syllables of a word commencing with that letter. For example, R (.—.) would be represented by such a word as "record'er" or "remem'ber" and other letters in a similar manner. Mr. Cole also fitted up in his room a simple receiving outfit consisting of a multiple tuner and magnetic detector with a few yards of wire attached to the hotel chimney as aerial; but, as the Ok Maidan station was not then working, the only signals we heard were those of the Rumanian passenger steamer in the harbour, which occasionally communicated with Constantza or Bukarest.

It was not until after the departure of the Marconi engineers that I realised how easy it would be to fit up a receiving station. With some difficulty I obtained the necessary wire for my aerial and the tuning coil. The latter consisted of many yards of thin cotton-covered wire wound by hand on a cardboard tube, with two sliding contacts. I also found a low-resistance telephone receiver, and a friendly British mining engineer provided the galena for my detector, but no tinfoil could be discovered anywhere for my condenser. Eventually I observed

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that certain chocolate slabs sold at the British stores were wrapped in just the kind of foil that I required. I obtained a quantity of these slabs and after completing my condenser the chocolate came in handy when listening of an evening to the music of the ether. The aerial consisted of four short copper wires, attached to a short pole on the roof, while the earth-wire was fixed to the water-pipe. This first installation involved an outlay of just about one pound sterling. It was afterwards much improved by the substitution of two coupled coils and the addition of variable condensers and two detectors, the one electrolytic and the other a combination of zincite and bornite. I also fitted up a transmitting set with the aid of a 3-inch spark coil, but as there was no other amateur with whom I could communicate it was not of much use.

At the time when my installation was completed, the Bulgaro-Turkish war was drawing to a close and the Turks were in retreat towards Constantinople. A massacre of Christians was feared, and in order to protect their subjects the Powers sent a fleet of about twenty-five warships to the Bosphorus. At the British Embassy a wireless station was established on the roof and kept in constant touch with our two warships. Most of these warships communicated with their bases by wireless in the evening, so that, as may be imagined, there was often a regular pandemonium of sounds in my telephone receiver. But as the messages were almost invariably in code I was naturally unable to understand them. However, the French warships occasionally communicated with one another in plain language and the *Goeben* often transmitted to her consort the German official war news in plain German. Then the Turkish station rarely used code at that time, while the Rumanian passenger steamers always transmitted in ordinary Rumanian or French. All the warships, excepting the French, emitted musical notes of various pitches, the highest being that of the *Goeben*, on which, of course, the Telefunken apparatus was used. The French ships gave out a low cracking sound like that of a machine-gun, which

GENERAL VIEW OF CONSTANTINOPLE, AND THE GOLDEN HORN.

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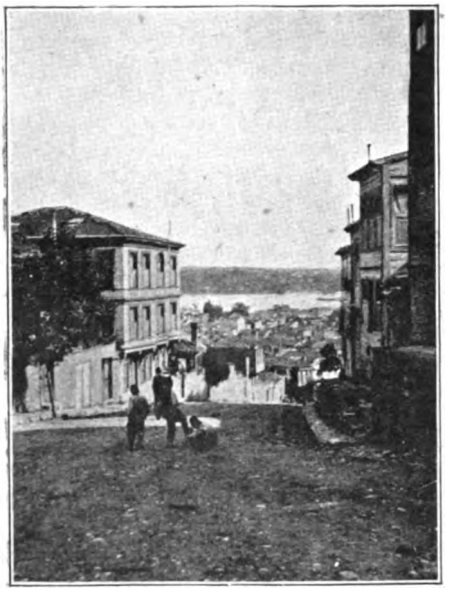

A GLIMPSE OF THE BOSPHORUS.

made it difficult at times to distinguish the dots from the dashes. Even with my small aerial the signals were so strong that they could be read many yards away from the receiver. Sometimes I placed the receiver upside down at an angle inside a glass tumbler, which intensified the sound and gave it a peculiarly penetrating ring. One evening I left the receiver in this position near my bed and was actually awakened in the middle of the night by the "peep-peep" from my tumbler.

The ordinary "continental" Morse was used for all the languages employing the Roman characters, but for Turkish, Greek and Russian it was considerably modified. A Turkish naval officer gave me the ordinary Turkish code, but I had to work out the Greek signals for myself. I jotted down the dots and dashes as they were transmitted and taking for granted that several of the letters or sounds common to both English and Greek would be represented by the same groups of signals I soon made out the complete alphabet. The chief difficulty was with the diphthongs, which have special signals.

The speed of transmission was usually high in the case of the warships, but the Turks tapped out the letters so slowly that one could write down the dots and dashes with the greatest ease and afterwards read the message at leisure. Ok Maidan was mainly engaged in communicating with the Turkish fleet, and also with Adrianople during the siege of that town by the Bulgarians.

With regard to "things heard" by means of my installation it will be seen that there was no want of variety in the languages and "notes" transmitted; but that was counterbalanced by the fact that most of them were signalled in code or cipher. It was monotonous to listen to an interminable array of figures or letters which conveyed no meaning, but there were occasional communications in "clear" language. One morning I overheard the Rumanian steamer in port spelling out a message in French addressed to Bukarest on behalf of the British post office at Constantinople. It was of a private nature, but I carefully wrote it out and on calling that same afternoon upon my friend the postmaster I casually placed it under his nose. His look of blank astonishment was amusing.

ENTRANCE TO THE MOSQUE OF AHMED I.

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"Where on earth did you get that?" he asked; "it's private."

"Well," I said, "there is nothing private about the ether from which I picked it up, and if messages are secret they should be sent in code; but, so far as I am concerned, it will not be disclosed to anyone." On another occasion I heard the German liner *Corcovado* in the harbour speaking in English to an Italian passenger steamer, then approaching Constantinople from the Dardanelles, with regard to the family of the American Minister, Mr. Morgenthau. As Germany was then at war with us (although not with the United States) this aroused my curiosity. The explanation, however, was simple. It appears that the American gunboat *Scorpion*, then in port, was trying to find out from the Italian steamer the time of her arrival, as a relative of Mr. Morgenthau was on board, but failed to attract her attention, probably because the *Scorpion's* transmitting power was insufficient. Accordingly she asked the *Corcovado*, which had a much more powerful installation, to relay on the message. But perhaps my most interesting experience at the "listening-post" was on the night when the *Goeben* and *Breslau* reached the Dardanelles after their break-neck race from Messina. I heard the *Corcovado* calling for "AGO," which I knew from the list in the Marconi *Year-Book* to be the call-letters of the *Goeben*, then supposed to be far, far away. The message was in open German, and stated that mechanics would be sent down as requested at once to execute the necessary repairs. Immediately afterwards the *Corcovado* called for "DGL," which I found to indicate the *General*, another German liner then somewhere outside the Dardanelles. A short message was first transmitted in open German, then followed a long communication in code. I suspected that the *General* would try to escape into the Dardanelles. Next morning the arrival of the *Goeben* and *Breslau* was announced in the Turkish papers, and two days later the *General* came into the Bosphorus with a dummy funnel and other disguise.

(*To be continued.*)

VIEW OF GALATA AND PERA FROM THE STAMBOUL SIDE.

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A Notable Personality

LORD PARKER OF WADDINGTON

A Famous Judge and Eminent Authority on Wireless Patents

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An Illustrious Jurist

Whose Intellectual Gifts Won Him High Distinction in the Field of Wireless

THE English Bench has in modern days produced no more luminous exponent of its best traditions than Lord Parker of Waddington, who died of heart failure on July 12th last at his home in Aldworth, Haslemere, in his sixty-second year. He was a thinker and student, as well as a lawyer, and some of his judgments are nothing less than epoch-making. One of the outstanding instances thereof profoundly affected the progress of radiotelegraphy. We refer to that which he delivered on February 21st, 1911, in the action brought by Senatore Marconi and Marconi's Wireless Telegraph Co., Ltd., against the British Radio Telegraph and Telephone Co. The subject-matter of the trial involved Marconi's basic patent, No. 7777 of 1900, besides two others filed by the great inventor. It is truly wonderful to read this classical pronouncement, which has formed the basis for numerous subsequent decisions, and to remember that the great lawyer who delivered it had no previous technical knowledge of wireless to guide him. The manner in which he disentangled ether wave telegraphy from that founded on magnetic induction, the lucidity with which he treated Marconi's innovation in the coupling and attuning of a closed oscillating circuit with an open radiating or absorbing circuit, and the clarity of reasoning which disposed effectively of the plea that an auto-transformer in use by the defendants and their possible employment of an inductive shunt relieved them from any onus of infringement, would have been remarkable in the case of an expert highly equipped with technical qualifications. Radiotelegraphy owes him a great debt of gratitude for having, by his remarkable intellectual power and analytical insight, cleared, once and for all, issues of the greatest importance and difficulty. Mr. Justice Parker (as he then was) won so great a reputation by his wireless judgment that, when in 1912 a Select Committee was appointed by the House of Commons to organise the Imperial Wireless Chain, the responsible post of Chairman to the Technical Advisory Committee was filled by him. To him, moreover, was assigned the task of presiding over the Wireless Telegraphy Research Committee, appointed by the Postmaster-General to investigate the most satisfactory methods whereby the State should make provision for research work into radiotelegraphic science. That report was issued in 1914 and resulted in the organisation being established in the form of an experimental establishment at the National Physical Laboratory at Teddington. The son of a Lincolnshire clergyman he "started in life" at Claxby in 1857. His education was conducted at Westminster School and Eton, and consummated at King's College, Cambridge. Called to the Bar by Lincoln's Inn in 1883 he maintained a connection throughout his earlier legal career with Mr. Ingle Joyce, afterwards Judge of the Chancery Division. Lord Loreburn appointed him to a judgeship after the return of the Liberals to power in 1906, and on the death of Lord Macnaghten, in 1913, Mr. Asquith promoted him over the heads of the five Lords Justices to become a Lord of Appeal in Ordinary, and a Peer for life under the title of Lord Parker of Waddington. He was chosen, despite the severe handicap of serious eye trouble, to preside in the Second Division of the Judicial Committee of the Privy Council, constituted in 1916 to deal with appeals from the Prize Court. Right up to the last he showed by his exposition in clear terms of great constitutional doctrine that his brilliant intellect remained undimmed by the tribulations of physical sufferings.

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On Valve Characteristic Curves and their Application in Radiotelegraphy

By J. SCOTT-TAGGART, R.E.

I

In the history of scientific discovery there is hardly a better example of applied physics than the use of the vacuum valve in radiotelegraphy. Moreover, there are few cases where graphical results obtained in a laboratory suggest so strongly practical applications of them. One has only to glance at a characteristic curve of a valve to grasp the practical potentialities of this comparatively recent invention. It is proposed in the following paper to enlarge upon the very valuable information we can obtain by the study of a number of such curves, and not only to explain some of the phenomena met with in actual work but to show how we may apply our information in designing apparatus and using the valve to the best advantage.

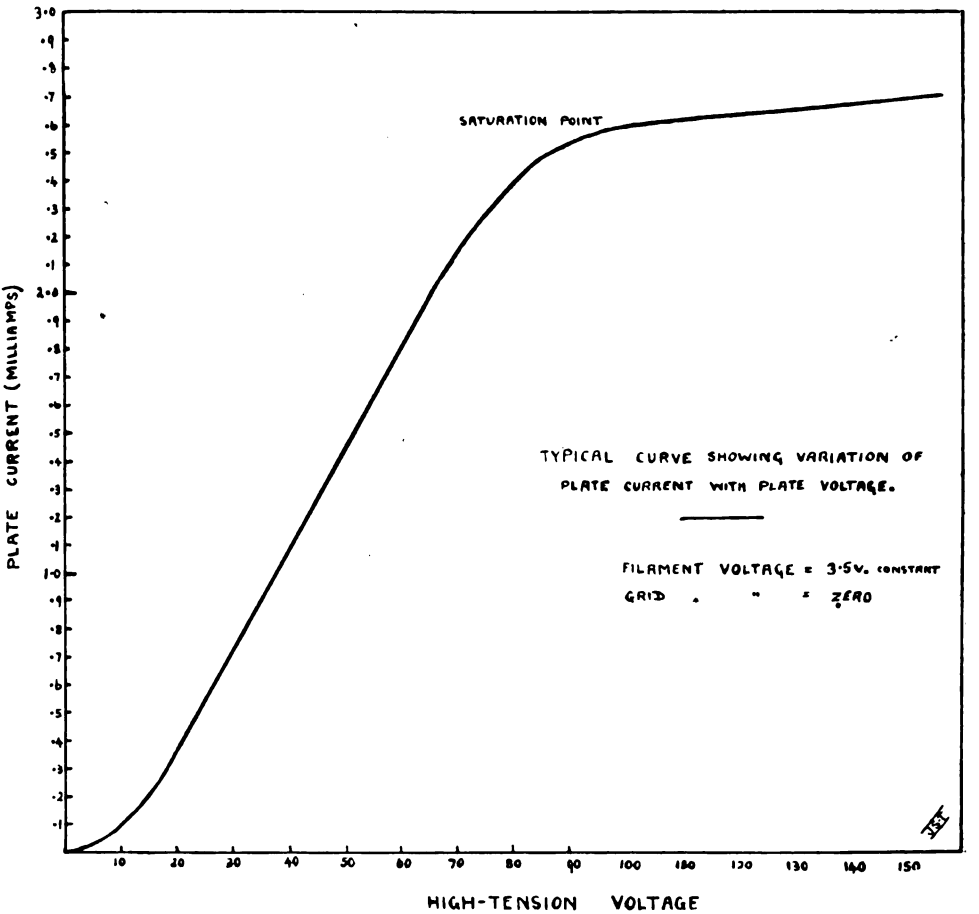
SATURATION POINT
TYPICAL CURVE SHOWING VARIATION OF PLATE CURRENT WITH PLATE VOLTAGE.
FILAMENT VOLTAGE = 3·5v. constant
GRID " " = ZERO
PLATE CURRENT (MILLIAMPS)
HIGH-TENSION VOLTAGE
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

FIG. I.

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The curves given have been obtained with a small hard valve, having a very wide-meshed grid, but they may be taken as typical of all hard vacuum valves used in receiving and transmitting circuits.

Let us first briefly summarise the elementary facts concerning valves. On heating the filament of a valve to incandescence, negative electrons are emitted. A further increase of temperature, produced by placing a higher voltage across the filament, results in a great increase in the rate of emission, which depends solely upon the temperature of the filament. If we connect a high-tension battery with its positive side to the plate, or sheath, of a valve and its negative side to the filament, a potential difference will exist between plate and filament, causing the negative electrons to flow to the positively-charged plate. Of the total number of electrons emitted per second only a certain proportion flow to the plate, the number depending upon the high-tension voltage applied. As we raise this voltage so do we increase the electron flow from filament to plate; this flow may be measured by a milliammeter included in the outer circuit.

Fig. 1, the simplest of the characteristic curves of a valve, shows how, by increasing the high-tension voltage, we also increase the plate current. It also shows us that at first the current increases slowly, then more rapidly, until, approaching saturation point, it begins to increase more slowly again, a point being finally reached when a further increase in the high-tension voltage produces practically no increase in the plate current. The plate has now attracted all the electrons emitted from the filament at that particular temperature. We see from this curve, then, that Ohm's Law does not apply in the case of valves. Had the valve acted as an ordinary conductor the "curve" in Fig. 1 would have been a straight line.

The next elementary consideration is the effect of grid voltage on the plate current. A positive voltage on the grid causes an increase in the plate current, and a negative voltage causes a decrease. In the following paper all voltages given will be relative to the negative end of the filament, and this end will be considered as having zero potential. If there is a potential difference of, say, four volts across the filament the potential of the positive end will be called + 4 volts. Sometimes the positive end is called zero and the negative end − 4 volts. It is purely a relative matter. In the following curves the grid is considered as having zero potential when connected directly to the negative end of the filament. Under these circumstances the grid may be considered neutral with respect to the filament. The grid, being at the same potential as the negative end of the filament, will be at a lower potential than any other part of the filament. There will, therefore, be no tendency for electrons to flow to the grid, and produce a grid current, although a few electrons are bound to strike the grid on their way to the plate. If we put a negative charge on the grid it will repel electrons which would otherwise have gone to the plate, and will also form a strong negative space charge round the filament, causing a considerable drop in the plate current. If, on the other hand, we place on the grid a positive charge of, say, 2 volts, the potential of the grid will be higher than the potential of any point on the lower half of the filament, assuming the potential difference across the filament to be 4 volts. A small grid current will therefore be set up. If the grid voltage is made + 4 volts, or higher still, the grid will be at a higher potential than any part of the filament, and electrons from every part will flow to the grid. In all cases, therefore, a positive charge on the grid not only greatly increases the plate current but also establishes a grid current

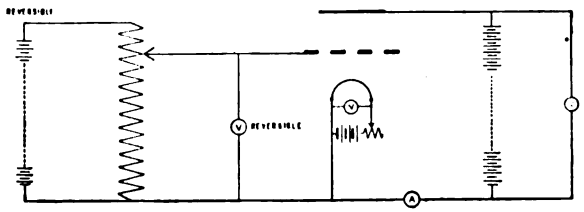

FIG. 2.

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of its own. This grid current, which plays an important part in the working of valves, will be discussed later in detail.

The most important characteristic curves of a valve are the ones which show the effect of different grid voltages on the current in the plate circuit. Fig. 2 shows a simple circuit for obtaining tabulated results from which the curves may be drawn. A potentiometer P is arranged so that variable positive and negative voltages may be given to the grid. This potential difference between grid and filament is measured by the voltmeter V. In the plate circuit may be included the 4,000 ohm primary of a step-down telephone transformer, to reproduce working conditions, and also a milliammeter A to measure the plate current. The filament current is variable by means of a rheostat, the exact voltage across the filament being noted for each curve.

In Fig. 3 we have a number of curves showing the relationship between grid voltage and plate current for different values of high-tension voltage, the potential difference across the filament being kept constant at 3½ volts.

Let us look first at the curve obtained when 33·5 volts are on the plate. From this we see that under normal conditions the plate current is ·8 milliamps. By putting a gradually increasing positive voltage on the grid we cause very considerable increases in the plate current until, at about + 12 volts, the plate current reaches a maximum value, and remains constant at about 2·4 milliamps. If, on the other hand, we put a negative charge on the grid, we reduce the plate current. By gradually increasing the negative charge on the grid we will ultimately cut off the plate current altogether. This, as will be seen from the curve, takes place at about − 6 volts. The effect of putting a higher voltage on the plate is to extend the height of the curve until it reaches a certain maximum height, and also to displace the characteristic curve to the left, as will be seen from such examples as the 54 volt, 82·5 volt and 100 volt curves. The curves are still approximately of the same shape and maximum steepness at the different plate voltages given.

It will be noticed also that as we reach the higher plate voltages the value of the saturation current almost ceases to increase. This is to be expected, since the real saturation point of the valve is being reached, when all the electrons emitted from the filament go to the plate. In the case of those curves which lie partly to the right of the vertical line through zero grid voltage, which in future we will call the grid zero ordinate, the grid is given a positive charge. It is the resulting flow of electrons to the grid, and the establishment of a grid current which chiefly prevents the 6 volt curve from reaching the same height as the 154 volt curve. If we added together the values of the grid current and the plate current at the saturation point of the 6 volt curve we would find that the total was approximately the same as the maximum current obtained on the 154 volt curve.

It will be clearly seen that by taking any of the curves of Fig. 3, and by suitably adjusting the voltage on the grid, we can use the valve at any point on its characteristic curve. When we speak of using the valve at a certain point on its curve we mean that the vertical line through the given grid voltage cuts the curve at that point.

Take, for example, the 82·5 volt curve. With no volts on the grid the valve is functioning almost at its saturation point; at − 5 volts the valve is working at a point mid-way along the straight steep portion of its curve; at 12 volts the valve is being used at the bottom bend of its curve. It will be seen later that it is of the utmost importance that we should be able to adjust the valve to that point on its characteristic curve at which it best carries out the function desired of it.

The same object may be achieved by varying the high-tension voltage, varying the filament current, and by varying the two together. Let us first see the effect of varying the high-tension voltage, keeping the grid voltage constant, say, for example, at zero volts. By placing 6 volts on the plate we are using the valve at

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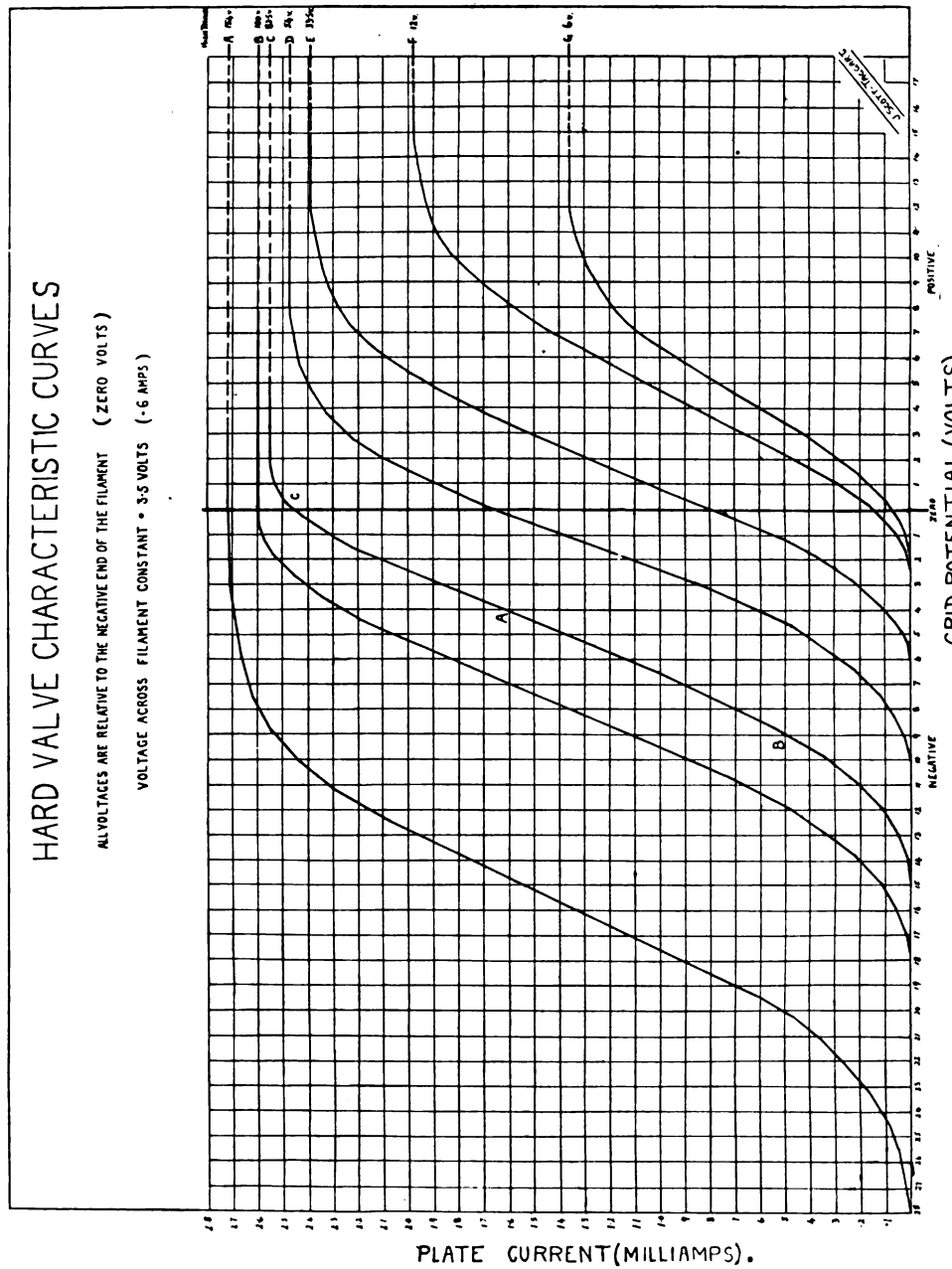

FIG. 3.

the bottom of its characteristic curve. By placing 54 volts on the plate the valve is functioning at about the half-way point along its curve for that voltage. By increasing the high-tension voltage to about 82 volts the valve is functioning near saturation point.

Let us now see the effect of putting a fixed voltage on the plate, say 33½ volts,

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and varying the filament current. By drawing a characteristic curve for each value of filament current we obtain the results shown in Fig. 4. They show us that by increasing the rate of electron emission we greatly extend the height of the curve, without actually displacing it bodily to one side as was the case when we varied the high-tension voltage. It will be noticed that all the curves have their lower portions in common.

Although the curve is not actually displaced to one side on increasing the filament current, yet the effect is almost the same as if it were moved to the right. By keeping the grid at zero voltage and using 3 volts across the filament, we are making the valve function at its saturation point. If we increase the voltage to $3\frac{1}{2}$ volts, we will be using the valve on the straight portion of its curve. If, now, we make the potential difference across the filament 4 volts or $4\frac{1}{2}$ volts, we will be using the valve at the bottom end of its characteristic curve. We see, then, from the four curves given, that, by having a rheostat to vary the filament current gradually, we can produce curves of any height within limits, and also arrange to have the valve functioning at any point without having to vary the grid voltage.

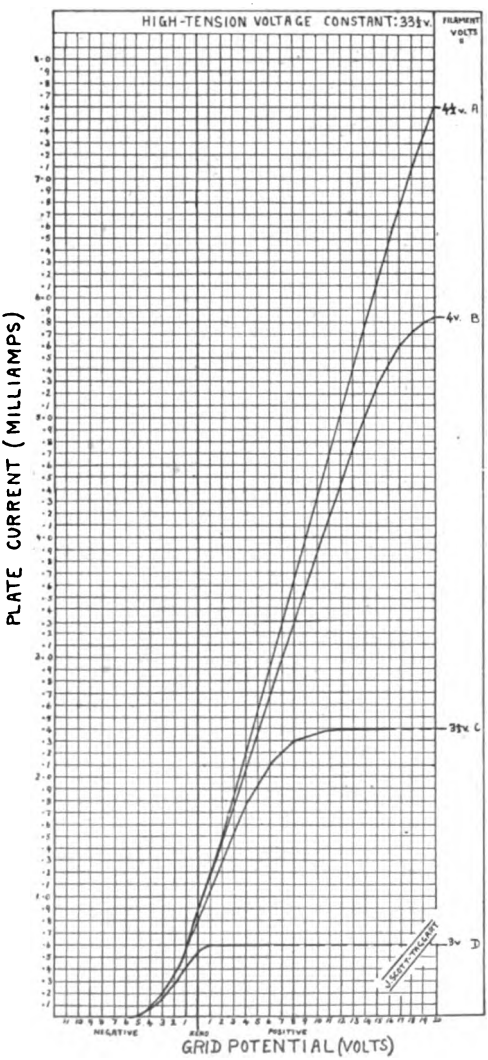

FIG. 4.

By having a variable filament current and high-tension battery we can produce almost any kind of curve, and displace it to either side of the grid zero ordinate to serve our special purpose.

Supposing, for example, we require to reproduce the 82·5 volt curve of Fig. 3 on a much larger scale: if we increase the high-tension voltage, we make the curve very little longer and also displace it to the left; if we keep the 82·5 volts constant, and increase the filament current, we will certainly increase the height of the curve, but at the same time we have done what is equivalent to displacing the curve to the right. The zero ordinate would cut such a curve about half-way up instead of near its saturation point. What we do, therefore, is to increase the height of the curve by using a higher value of filament current, and then to displace it to the left into the desired position, which is completely to the left of the zero ordinate, by using a higher value of high-tension voltage. This increase of voltage also adds to the height of the curve.

(To be continued.)

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Digest of Wireless Literature

Weagant's Method for Group Frequency Tuning.

Experiments have shown that when the local circuit of a radio receiving system is fitted with a group frequency or audio frequency tuning circuit a diminution of the strength of signals results. A system has recently been disclosed by Roy A. Weagant, chief engineer of the American Marconi Company, wherein group frequency tuning is possible without the usual loss of signals. The connections are shown in Fig. 1. The primary and secondary windings of the receiving tuner are indicated at 3 and 5 respectively, the shunt condenser at 12, a solid rectifier at 6, and a series condenser at 7. The group frequency tuning circuit includes condenser 7, a variable condenser 11, a variable inductance 10, and the head telephone 9.

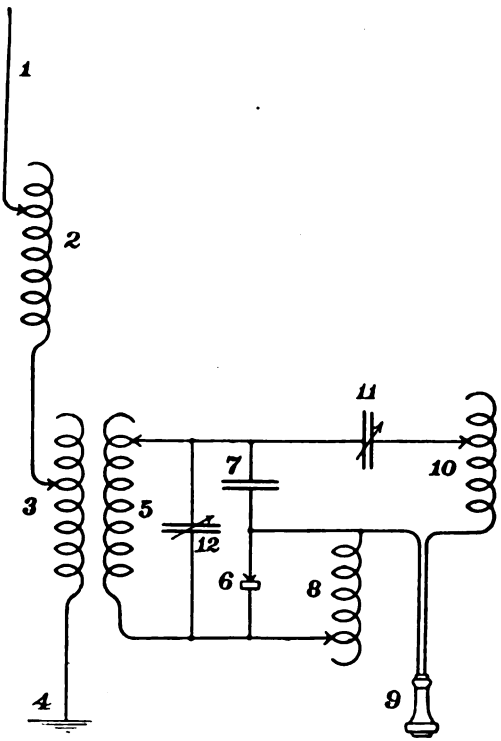

FIG. 1. WEAGANT CIRCUIT FOR GROUP FREQUENCY TUNING.

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Detector 6 is shunted by a coil 8, which has the effect of maintaining the signals in the telephone 9 at the strength which would be secured were the group frequency tuner removed. The principle of operation is somewhat as follows: The detector 6, while permitting the passage of impulses in one direction, tends to prevent their passage in the other direction, and thus interferes with the oscillation of the circuit. By placing an impedence in shunt with the detector, however, a path is provided for the passage of oscillations in both directions, thus improving the operation of the circuit. The impedence 8, being of relatively high value, does not, however, interfere with the operation of the detector in the case of high frequencies. Mr. Weagant states that the best results are obtained when the inductances 8 and 10 are substantially of the same order, each of them being about 1,000 times the inductance of the secondary 5.—*Wireless Age.*

Constants of Radio-telegraphic Stations.

At present there is a lack of simple characteristic constants to define the power of sending and receiving stations in wireless telegraphy. The usual method of defining the antenna of a sending station is by the number of watts calculated from the antenna current and antenna resistance. As this does not take any account of the radiating properties of the antenna, it does not lead to a means of calculating the range of the station. In the case of receiving stations only figures of the most general kind are generally given. The author purposes a system of constants that he has devised in a series of experiments with the help of Zeppelin airships.

It is assumed that the sending station emits undamped waves, that the surface of the earth is a good conductor, and that absorption of the energy in its passage between the stations may be neglected. All constants are referred to a definite wave-length, azimuth and current in the sending antenna.

The "Sending Constant" S is defined as the number of watts that the station sends through a surface of one square mile, perpendicular to the radiation and r km. distant: this would have different values for different azimuths with directive antennæ, or if the earth had different resistance in different directions.

The "Receiving Constant" E is defined as the area in square miles from which the antenna absorbs all the radiated energy. It thus follows that the number of watts γ measured at the receiving station is given by $\gamma = E\,S/r^2$.

According to the sensitiveness of the receiving apparatus there is a lower limit to the power P, at which signals are just audible, given by $\gamma = n\,P$, where n must be greater or equal to unity. If $n=1$, the energy used is just sufficient for the reception of signals, and the stations are at the greatest permissible distance R apart. This distance is $R = \sqrt{(E\,S/P)}$ km.

From the number n of receiving units that are measured at a distance r, the maximum range of the stations may be calculated from the equation $R = r\sqrt{n}$ km.

If the current I in the receiving antenna is measured instead of the watts, we have $I = K/r$, where $K = \sqrt{(E\,S/p)}$ and p is the antenna resistance.

If signals are received from two sending stations the ratio of their sending constants is equal to the ratio of the quantities γr^2 for each of the stations. On the other hand, if two receiving stations measure the power received from a single sending station, the receiving constants of these stations are proportional to the same quantities. Lastly, if two stations are at a variable distance apart, the distance may be calculated from the relations $r_1/r_2 = \sqrt{(\gamma_2/\gamma_1)} = I_2/I_1$.

Corrections are necessary if the waves are damped and if there is absorption of the radiation. The damping constant $B = 8_2/(8_1+8_2)$, in which 8_1 and 8_2 are the decrements of the primary and secondary circuits. The absorption constant K is given by $K = e^{-Ar}$, in which $A = a\sqrt{\lambda}$, according to the formula of Cohen, λ being the wave-length. The conclusions stated above will now hold, if each sending and receiving constant is divided by the corresponding value of B/K.

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It will be noted that the absorption correction for S and E will be very small if the distance between the stations does not vary over wide limits. Stations used for measurements of the nature indicated should supply polar curves showing the value of S for different wave-lengths, antenna currents and azimuths. Airships afford the best method of producing such diagrams owing to the absence of earth resistance, and to the fact that they can approach the sending station near enough for the absorption correction to become neglig.ble.—(M. Fieckmann, from "Zeitschrift für Flugtechnik und Motorluftschiffahrt 1914," *Jahrbuch der drahtlosen Telegraphie*, April, 1918).

Range and Best Wave-length for Wireless Telegraphy.

The Austin-Cohen formula is commonly used in designing wireless stations. This formula gives the magnitude of the current in the receiving antenna as a function of the characteristics of the receiving and emitting antennæ, the wave-length, and the distance between the stations. The author transforms the equation, so that the various quantities are involved in a consistent system of units, and then obtains a modified expression for the radio-telegraphic efficiency of the system. The equations are somewhat cumbersome, and graphical methods are given for applying them to obtain numerical results.

The first investigation refers to the range of the station. In calculating the best wave-length to use it is usual to assume that the radiation resistance is small in comparison with the ohmic resistance in circuit at the emitting and receiving stations. The corresponding wave-lengths and distances of transmission are first worked out on this supposition, and subsequently the case is considered in which the above assumptions are not true, such as is the case with short wave-lengths, high antennæ, and good earths. In this case it appears that the efficiency grows with the length of the wave used. As a last case, it is assumed that the radiation resistance is large in comparison with the ohmic resistance at the sending station, and the efficiency of the sending antenna is approximately equal to unity. In the receiving station it is assumed that the earth resistance and the antenna resistance are small in comparison with the equivalent resistance of the detector. On this basis it is calculated that the efficiency of the system, calculated as the ratio of the mean power available at the receiving station to the mean power emitted by the radiating station is given by $n=[(3/8)\ n\lambda/r]^2$ where λ and r are the wave-length and distance of transmission between the stations. Lastly, an abac is constructed, from which the characteristics of operation of a station may be easily read off. The quantities obtainable by its use are the current in the receiving antenna, the range of the station, and the best wave-length to employ.—(L. Bouthillon, *Revue Générale de l'Electricité*, March 23rd, 1918).

Guatemala Joins In.

We notice the announcement in our American contemporary, *The Wireless Age*, that the Republic of Guatemala has "thrown in her lot with her big sister, and declares that she stands by the United States." Although this Central American Republic is little larger in area than the State of New York, and her population is estimated at only about two millions, such action on her part is alike useful and significant. Useful because she possesses a seaboard both on the Atlantic and Pacific Oceans, and this accession on her part will prevent any chance of the establishment of secret wireless stations or German U-boat bases on either littoral. Significant inasmuch as it indicates the moral effect of the action against Germany taken by our American cousins.

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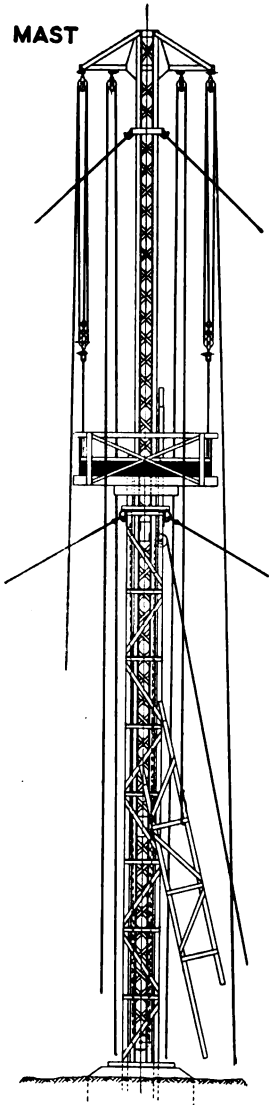
165 FT. LATTICE STEEL MAST FOR MULE TRANSPORT.



DETAIL SHOWING METHOD OF MAST ERECTION.

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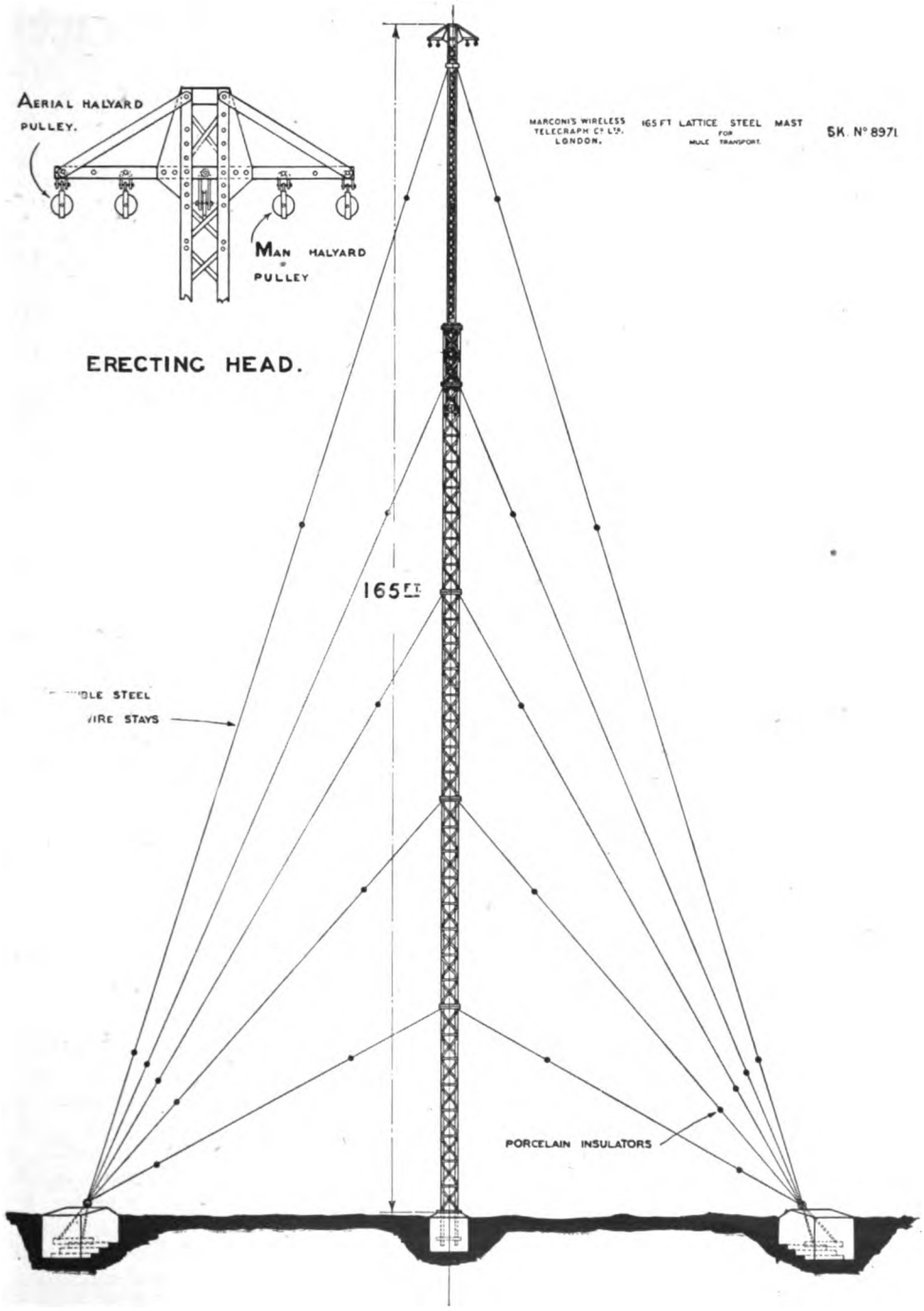

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The Home Study of Electricity

An Important New Aid

A certain justifiable distaste for science has arisen in the minds of many students, owing to the dry and uninteresting manner in which text-books are written. Electricity has suffered from such treatment perhaps more than any other science, and it is safe to say that the great majority of electrical manuals have virtually no points of contact with our daily life. Neither, for that matter, do they attempt to clothe the dry bones of the subject with anything approaching a living interest, so that unless the student is prepared to face a dreary vista of frogs' legs, catskin sealing wax, and obsolete apparatus, and to swallow a vast collection of facts unquestioningly, he may as well give up all hope of advancement at the outset.

Far removed from this category must be placed the interesting volume* which it is our pleasure to review this month. With considerable experience as an instructor behind him, Mr. Penrose has not hesitated to throw overboard the accepted conventions surrounding electrical instruction, and as a consequence has produced a book original in treatment and calculated to interest old and young alike.

The keynote of the volume is sounded in the preface. "In departing from the orthodox methods adopted in standard text-books the author in no wise wishes to disparage those methods; indeed, the ultimate object is to encourage the large body of students who, he knows from past experience, need a stimulated enthusiasm in order to overcome a genuine dislike for mathematical reasoning. If, therefore, in parts, a somewhat severe demand has been made upon the 'Electron' theory, it must be remembered that these lessons are intended to present facts vividly to aid the non-mathematical mind in following the truths expounded in standard works."

If there is one virtue in the book which shines out above all others it is that difficulties are not avoided, but faced and overcome in a straightforward and lucid manner. Thus, although the book is designed for those who have no previous knowledge of the subject, such matters as the hysteresis cycle and curve, the Wheatstone bridge, ring and drum windings of armatures, and the various problems connected with the electric motor, are all fully dealt with in such a way that few can fail to grasp their purport immediately.

Capacity and inductance are also thoroughly treated, in spite of the fact that most elementary volumes leave these subjects severely alone.

A special word of commendation must be given to the manner in which the book is arranged. The whole volume is divided into fifty lessons, each of these being preceded by a list of inexpensive elementary apparatus by the aid of which the student may test for himself the truth of the assertions made. At the end of each lesson will be found a list of questions to be answered before the next lesson is commenced, and thus the student may test his progress throughout the various stages. The volume is thus particularly suitable for home study, although, of course, it is just as useful for class work.

The thoroughness of the general treatment, and the particularly clear manner in which inductance and capacity are dealt with, makes this book eminently suitable for those who are entering upon the study of wireless telegraphy, whether for professional purposes or merely as a branch of general education. The volume, which is illustrated with numerous diagrams and figures, contains over 500 pages, with a copious table of contents and index, and is certainly one of the most interesting it has been our good fortune to meet.

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* *Magnetism and Electricity for Home Study.* By H. E Penrose. London: The Wireless Press, Ltd. 5s. net.

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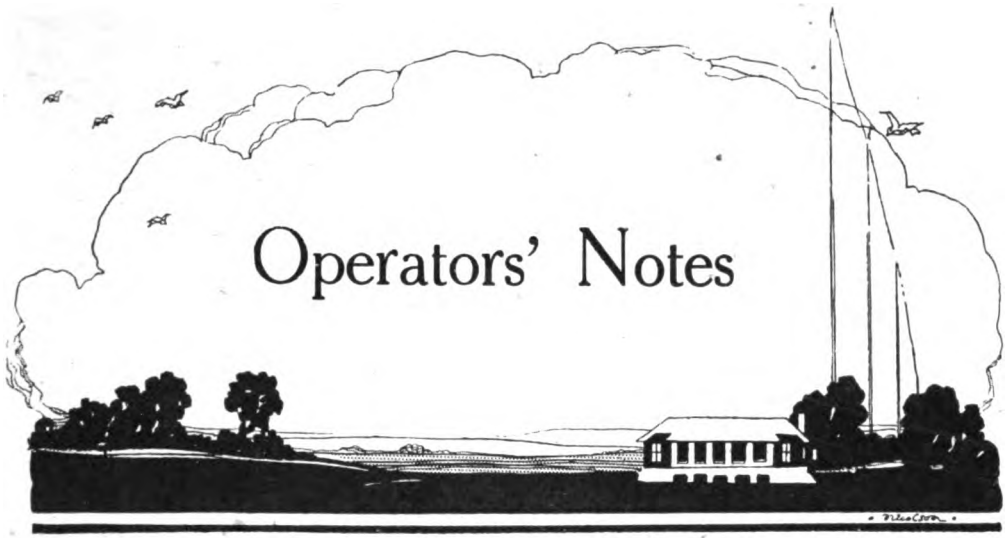

Wires and Wiring (II.)

By ROTAREPO

WHEN joining wires together it is essential that they should make good and constant contact, in other words, the joint must be firm. Loose joints always give trouble, more especially so in wireless receiving gear where the available power is too small to overcome imperfect contacts. These carelessly made joints are the most common source of that tantalising and hard-to-locate fault, "intermittent sigs."

To ensure firm joints solder should be employed wherever possible, though discretion must be exercised in the application of heat. It is well to adopt the rule of using no more heat than is absolutely required. It cannot be too strongly emphasised that excessive heating tends to make the wire brittle, to say nothing of the damage liable to be done to the insulation, both of which tend to greatly reduce the efficiency of the station. It has already been pointed out in these pages that the soldering iron should be used in preference to the blow lamp for wire joints, and the system to be adopted was explained by Mr. Ward in the June issue.

Sometimes it is necessary to make a joint for a "tapping off" lead at some central point of an existing main lead. In this case the procedure should be as now described. Bare and clean a short length of the main wire at the point desired, which length will depend upon the size of wires to be joined—usually an inch will be sufficient. Bare and clean about two inches of end of tapping wire and then bind tightly round the bared portion of main wire, finishing off with solder and insulating tape.

Where the tapping-off wire is composed of more than three strands, a more satisfactory joint is formed by cutting out the core, and then twisting each half of the remaining strands in opposite directions around the main lead. Naturally it will be necessary to bare twice as much of the main wire as would be required for forming the previous joint.

Whenever it is necessary to twist one wire round another always tighten up the turns by the aid of the pliers, taking care, however, not to break the wire.

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The foregoing include all the ordinary joints proper which are likely to be required at sea, except, of course, for splicing, which unfortunately defies clear and adequate explanation on paper, and which can only be taught by ocular demonstration; the remainder of this article, therefore, may be fitly devoted to the manner of finishing off ends of wires for "jointing" to apparatus.

The most common "finishing" to wires in an operator's cabin is the lug, of which the two main varieties are those having "eyes"—that is, holes drilled through a flattened end—and those having open ends or large "slots." All types, however, have one tubular end in which the wire is to be affixed with solder. "Eye-lugs" are used for semi-permanent connections such as leads to switchboards, starter, etc., whereas "slot-lugs" are used where wires have frequently to be disconnected—for example, accumulator leads and connectors. Lugs intended for cotton or silk-covered wires are fitted with a removable sleeve, which is slightly longer than the tubular end of lug. The use of these sleeves will be shown later.

To fix a lug on to a wire commence by baring the end for a length slightly longer than the depth of tube of lug. Clean this thoroughly and, if a multiple wire, twist up the strands with pliers. Hold the lug in the vice and place in the tubular end, which should be up, together with a small amount of flux and a little piece cut off one of the solder sticks. Pull back as far as possible the cotton or silk covering, and put sleeve on wire with wide end away from end of wire to be soldered. Then hold the wire in right hand, having dipped its cleaned end in the flux, and heat the lug with flame of blow-lamp until the solder melts. Now, having held the bared wire for a moment or two in the flame, push it slowly and steadily as far as possible down the tube. After a few seconds remove the flame and hold the wire steady until the solder sets, when the lug should be found to be firmly fixed to the wire. If the solder won't "take"—that is, stick to the wire—it is a sign of dirt or insufficient flux. Presuming the joint to be satisfactory, remove the lug from the vice, push back the silk cover of wire and slide the sleeve into its place, which will cover up any small portion of the insulation which may have got scorched in the process.

If lead-covered cable is being used the lead should be removed for about half an inch further than the insulation, because otherwise the metal sheathing might touch the lug, in which case it would become "live" and probably cause a serious short circuit.

Sometimes a lug breaks off the wire, in which case the stump of wire and solder can easily be removed from the tubular end by holding the lug upside down with the pliers and heating it until the solder melts and runs out.

If a lug is not available, but a good joint for a terminal connection is required, all that is necessary is to bend the bared ends of wire, after tightly twisting up the strands, into a loop just large enough to pass over the pillar of the terminal when nut is removed. This loop should be well coated with solder in order that it may retain its shape.

When putting this type or, in fact, any wire on to a terminal put it on in such a manner that the nut, on being screwed up, tends to close the loop and not *vice versa*.

The two ends of aerial down-leads which fit into their appointed terminal holes on the Bradfield will give better contact and wear longer if the strands are twisted up, cleaned, and well soldered.

"Seizing" or "whipping" the ends of aerial wire—that is to say, binding with string or wire to prevent the ends fraying out—is very simple in execution, though, like splicing, defies explanation. However, after watching an A.B. once or twice it is readily picked up.

When connecting wire to lamp sockets, etc., bare about twice as much as is required to pass through the porcelain to screw grip and, having bent this double, twist it up firmly before inserting it in the holder. This gives a better contact, and prevents the screw from cutting through wire if it be too tightly screwed up.

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A Distinguished Trio

LINKED BY A SEQUENCE OF ORGANISED SCIENTIFIC WORK

Some attempt to illustrate the Romance of Science from past and present happenings.

By H. J. B. WARD, B.A.

WAS there ever a more ridiculous piece of crass incomprehension than the legend that Romance and Imagination are alien to science? Yet such an opinion was seriously held by a large number of our immediate forefathers. The humblest scientific student nowadays knows better; but the point cannot be too frequently emphasised, and it is hoped that the following brief account may "point the moral," even if it does not "adorn the tale."

THE GOLD MEDAL RECENTLY AWARDED TO SENATORE MARCONI BY THE FRANKLIN INSTITUTE OF PHILADELPHIA.

In our June issue we announced that the Franklin Institute of Philadelphia had recently awarded their medal to Senatore Marconi. On this side we fear that not a few readers may have asked themselves the question, "What is the Franklin Institute?" and we are certain that quite a number queried "What has the Franklin Institute to do with Radiotelegraphy?" γνῶθε σεαυτόν was inscribed in gold letters over the portico of the oracular temple at Delphi,* and was regarded by the old Greek philosophers as the beginning of wisdom. Assuredly the self knowledge of which the ancient apothegm speaks would require but little stretching nowadays to cover our close blood-relations of the U.S.A. It may therefore be not inapposite under present circumstances to trace the romantic story of this scientific chain in the following brief résumé.

Three great men stand out as the Eponymous Heroes of the tale, triple links

* Or, as Alexander Pope puts it:

"Know then thyself, presume not God to scan;
The proper study of mankind is man."

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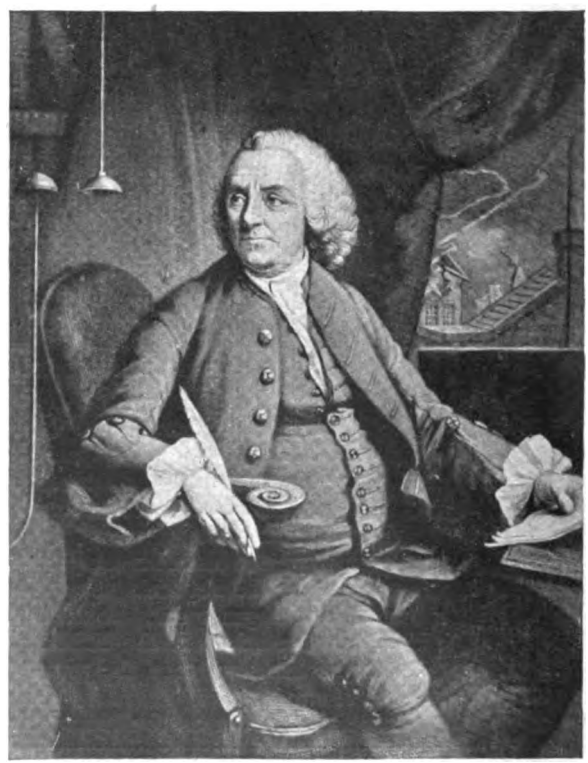
COUNT RUMFORD (*né* Benjamin Thompson), FOUNDER OF THE ROYAL INSTITUTION.

of the first importance in the sequence of events. These three are Count Rumford, Benjamin Franklin and Guglielmo Marconi. Let us take them in order :—

In 1753, at Woburn, in Massachusetts, there was born—of old Colonial stock—Benjamin Thompson, a man of high ability and catholic interests, with an especial bias towards the physical sciences. Owing to the fact that he chose the side of England, then drifting into conflict against her American Colonies under the guidance of her German Kings, Mr. Thompson was constrained to desert the New World for the Old. For his "loyalty" to the "Ancient Order of Kings" he was awarded the title of Count Rumford by the Elector of Bavaria. He became a Fellow of the Royal Society (London) in 1779, and endowed the two Rumford Medals, which still form notable items amongst the awards of that famous Institution. Not content merely to maintain his connection with the Royal Society, he founded in 1799 the almost equally important scientific organisation known under the title of the Royal Institution. This Institution is devoted to the objects of (*a*) encouraging inventions in mechanics, and (*b*) of furnishing opportunities for the study of applied science. In 1804 he married the widow of Lavoisier, the celebrated French pioneer in chemical research, and died at Paris in 1814.

The Royal Institution Buildings in Albemarle Street, Piccadilly, the home of an organisation which ought to be familiar to every wireless man, constitutes the most enduring memorial possible to the memory of this eminent American. Within its walls Faraday achieved the epoch-making discoveries which lie at the root of many of the manifold applications of electricity that enrich the modern world. The historical apparatus employed by Davy,



BENJAMIN FRANKLIN AS PICTURED BY CARPENTER.

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by Faraday, by Odling and by Tyndall find a place within its *enciente*, and for over a hundred years the Society has been applying itself to the noble objects of its foundation, " the promotion, diffusion and extension of science, particularly in the realm of useful knowledge."

Such is the first person in our trilogy, an American of the old Colonial days fired with enthusiasm for practical scientific research. Our second personality resembles him in certain particulars, but differs widely in others.

The youngest son and fifteenth child of a family of seventeen, Benjamin Franklin first saw the light at Boston, Massachusetts, on January 17th, 1706. Much of his early career appears to have furnished material to Mrs. Humphry Ward for her description of the boyhood of *David Grieve*. Franklin's origin was as humble as Thompson's was illustrious, and it took him many years of struggle before, at the age of 40, he was able to commence those fruitful researches in electricity which gave him front rank amongst the most original of natural philosophers. Mr. Carpenter's picture (p. 326) shows his demonstration, by means of a boy's kite, of the identity between lightning and electricity which had—up to his time—been a matter of doubt. Within seven years the Royal Society of London recognised his achievements by a fellowship; but he, unlike Thompson, ranged himself on the side of the American Patriots, and the greater part of his later life was devoted to political objects. Our illustration on page 328 depicts the house in Craven Street, Strand,

THE FRANKLIN INSTITUTE, SEVENTH STREET, PHILADELPHIA.

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STATUE OF BENJAMIN FRANKLIN ERECTED AT PHILADELPHIA

a National Memorial to his memory and for the expressed purpose of meeting a demand in America for an organisation similar to the Royal Institution founded by Count Rumford in London 25 years previously. The great American is said to have estimated as the most enduring section of his life work his contributions towards the discovery of physical and natural laws, and more especially the application thereof to the well-being and comfort of mankind.

These are the objects set before itself by the Institution which bears his name, and which recently bestowed its annual medal upon Senatore Marconi, whose achievements in the realm of radiotelegraphy have furthered the cause of humanity to a degree unsurpassed in the annals of science.

Our illustration on page 327 depicts the front of the Institution Buildings, located on the east side of Seventh Street, which formed his residence during his sojourn in Britain's Metropolitan City, his visits to which came to a final termination in the critical year of 1775. Alike as *littérateur*, scientist and patriot, the name of Franklin is venerated throughout the United States, and indeed all over the civilised world, whilst his early connection with the printing craft finds a fitting memorial in the *Saturday Evening Post*, one of the most popular of American weeklies, which owes its foundation to him.

Benjamin Franklin retired from political life in 1785 and spent the remainder of his days in Philadelphia. It was in that famous Quaker city, during the course of 1824, thirty-four years after his death, the Franklin Institute was organised, as

THE HOUSE IN CRAVEN STREET, STRAND, AT WHICH FRANKLIN STAYED WHEN VISITING THE BRITISH METROPOLIS.

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Philadelphia (between Market and Chestnut Streets), and which was built from plans furnished by the well-known architect, John Haviland. The corner stone was laid on June 8th, 1825, and the official journal (founded a year later) has proved of invaluable assistance in promoting the development of the Institution, and in perpetuating the distinctive character which it has consistently maintained.

The Gold Medal, of which we furnish an illustration on page 325, is awarded annually from the Franklin Medal Fund, founded on January 1st, 1914, by Samuel Insull, to those workers in physical science or technology, without regard to nationality, whose efforts have done most to advance a knowledge of physical science or its application. Our picture bears witness to its high artistic merit, and it is not unworthy of mention that the intrinsic value of the medallion, awarded to Senatore Marconi, the third person of our trio, amounts to about seventy-five dollars. The great Italian inventor has been too prominently in the public eye during recent years to need any biographical notice here; but it is worthy of remark that, amongst all the many distinctions showered upon him, he values, in no ordinary measure, this award of the Philadelphian Institute.

Although—as we have seen—of but recent foundation, the distinction is both rare and highly prized, numbering amongst its recipients Thomas Alva Edison, the notable American inventor, and Hendrik Antoon Lorentz, the eminent Dutch physicist, whose researches into the nature of light and the ultimate constitution of matter have won for him world-wide renown. Senatore Marconi was in Italy on his country's business when the award was made, and His Excellency Count V. Macchi di Cellere, the Italian Minister at Washington, attended at the Institute on Wednesday, May 15th, and received the medal in the place of his distinguished compatriot from the hands of President Clark, the present Chief of the Franklin Institute. The actual ceremony of presentation was by no means lacking in picturesqueness of detail, and we would refer interested readers to the detailed account published in the *Journal of the Franklin Institute*, No. 1,826, for July, 1918. The President, Mr. Walton Clark, called upon Dr. Harry F. Keller, Member of the Board of Managers, to make the official statement relative to the work of Senatore Marconi and the reasons which prompted the Institute to make the award. Dr. Keller's address was worthy of the occasion, and he made a touching reference to the fact that "the creator of the wireless art has not been spared the experience of unjust and ungenerous attacks upon his claims by envious rivals and competitors." Count Cellere delivered a proper response, the gist of which will be found in THE WIRELESS WORLD for June last. We would only add here a passing reference to the association, touched upon by His Excellency, between the distinguished personalities of Galileo, Volta and Franklin. The reference to the award in the minutes of the Institute runs as follows:—

"In recognition of his brilliant inception and successful development of the "application of magneto-electric waves to the transmission of signals and telegrams "without the use of metallic conductors."

The achievements of the Franklin Society include such important services as the inauguration during 1831 (in concert with the American Philosophical Society) of systematic meteorological observations which have proved of such immense utility to American agriculture. Moreover, without any Federal or State aid the Institution in 1884 held the first great International Electrical Exhibition which produced wide-reaching effects upon the development of that industry, including the initiation of the American Institute of Electrical Engineers.

One of the effects of the present war will undoubtedly consist of a closer union in every field, industrial, scientific, and social, between the British Empire and the great republic overseas. Union implies knowledge and co-working, so that every step towards a fuller realisation of the aims, endeavours, and institutions of the two branches of the Anglo-Saxon race will aid materially the realisation of that fraternal concord which both have so much at heart.

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Police Wireless in New York

An Illustration of the Way in which Radiotelegraphy is Used on the Other Side

THE accompanying illustration shows a wireless telephone and telegraph motor truck placed in service by the New York Police Department Signal Corps. This equipment was designed to be kept constantly in commission as an emergency precaution in case of failure of the ordinary means of communication from any cause whatever during the war. The antennæ extend from one high mast on the front of the truck to a shorter mast at the rear of the truck, eight conductors being used for collecting the electric waves for the coherers of the receiving instruments or for transmitting the messages sent from the wireless truck.

NEW YORK POLICE CAR FITTED WITH WIRELESS

A police army several thousand strong may be called into service in the municipality on short notice. Dressed in khaki uniforms and completely armed and equipped, a parade in which the wireless truck was a feature passed in review under federal military authorities from Fort Wadsworth, Staten Island. The parade included, in addition to the battalions of police infantry, a machine-gun detachment, a mounted troop, the wireless and signal corps and a hospital corps.

The wireless motor truck is a most essential part of the signal equipment of every army in Europe and America and it is rendering wonderful service in modern warfare. The establishment of these cars is not only interesting in itself, but constitutes a striking illustration of the way in which wireless telegraphy is permeating every phase of modern life.

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Wireless Telegraphy In the War

Aerial Post.

We noticed the other day the following paragraph in one of our daily contemporaries, dated from Amsterdam :—

"According to a statement made by the Director-General of Posts and Tele-
"graphs the Dutch postal authorities are negotiating through the Foreign Office
"with the British Government concerning the possibility of an aerial post to and
"from London."

We do not think that the "dearest friend" of The Wireless World can accuse us of an unsympathetic attitude towards enterprise or innovation. With regard to this very matter, under the heading of "Navigation in the Ocean of Air," we published a short article in our August, 1917, issue, treating with favourable anticipation the idea that the air might furnish us with a means of communication more speedy than any attainable by utilisation of the denser medium of the sea. No doubt the time will come, and that speedily, when express letter mails will be transported, even over long distances, by aircraft of one sort or another. But much will have to be considered and settled ere such a project can be carried into practice, as far as different national entities are concerned, and it is more than doubtful whether such consideration and settlement can be satisfactorily carried through until the present conflict shall have ended. The problems involved would be difficult enough of solution even between countries "pulling in the same boat." It is true that for some considerable time there has been running in America a regular "Airplane Mail Service" between New York, Philadelphia and Washington, but in this case both the point of departure and of arrival are situated in the same country, and the route passes over no territory that is not controlled by the Government which runs the service.* For a belligerent country to allow the establishment of an aerial post between itself and *a neutral*, especially when that neutral is contiguous to, and liable to be bullied by, the arch-enemy of humanity, would be simply "to ask for trouble."

Wireless is so inextricably linked with aircraft (almost indeed as intimately as with navigation at sea) that some of the crucial questions connected with the subject of this development of aerial post centre round the science of ether wave-transmission. Imagine for a moment that an agreement covering an aerial postal service with the Netherlands has been reached, and that Dutch postal aeroplanes are making daily

* It is interesting to note the latest figures published in the Official Bulletin of the U.S.A. wherein the Post Office Department reports that the total possible number of flights during the month of June were 100. Actually uninterrupted, complete flights numbered 88; the flights interrupted from one cause or another were only 8; whilst the total flights defaulted on account of weather amounted to no more than 4. The distances flown ranged between 340 and 450 miles.

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journeys. The route to be followed would, of course, be laid down between the two countries. But how are we to feel any certainty that this route would be adhered to? We have no aerial police appointed for the purpose, and our own naval and military machines are none too many for our immediate requirements. Are we prepared to allow neutral pilots, possibly with personal predilections favourable to the enemy, to hover unchecked over our countryside? Moreover, for their own safety, and for the efficiency of the service, these aeroplanes must be fitted with wireless. Are they to have liberty to receive and transmit wireless messages at will, uncontrolled by any British censor, whilst flying over our fields, our cities, and our Fleet? If they are not to be allowed this status of "licensed libertines," how are we to prevent them from assuming it? How about enemy aircraft camouflaged as Dutch?

Apart, moreover, from any consideration of the intricate technical, tariff, and other problems with which the proposal bristles, there is the further matter of the iuncture at which the suggestion is being made. Just at the moment when the British people are forcing their Government to take some steps, all too inadequate, to close some of the avenues by which information reaches the enemy, we find such a proposal as this, put forward by a neutral Government which has, in the opinion of some of us, been already allowed to pursue various courses of action none too favourable to British interests. The potentialities of aircraft recently received a striking demonstration when Major-General Davidson, desiring to "take his seat" after election to the House of Commons, left General Headquarters in France in the morning, reached England by aeroplane, motored from his landing place to Westminster, took the oath, sat in the House for a little while, and finally returned to his duty in France again, before the Parliamentary debate he set out to attend had been concluded. This gallant officer belongs to our fighting forces, and is under the control of our military authorities; but had he been of neutral nationality, acting as temporary postman, he could have laughed at any of our Aliens Restriction Acts and set at nought our passport regulations. As the Troelstra incident recently exemplified, there are often delicate matters of diplomacy involved under present circumstances; why magnify their difficulty manifold? Surely in all these matters, as in that of the neutralised alien, we ought to be guided by the motto "give your own Motherland the benefit of the doubt."

AEROPLANES AND WIRELESS.

The ever-increasing closeness of relationship between wireless and aeroplanes is emphasised in the Third Annual Report of the American National Advisory Committee for Aeronautics. This report, which reviews the work of the Committee during the year ending June 30th, 1917, has just been issued. Mention is made therein of the fact that the Committee co-operated in the development of a generator for wireless transmission from aeroplanes intended to satisfy the requirements of the American Army and Navy. The Advisory Committee also instigated investigations into the various methods of receiving wireless signals in aeroplanes on active service, and their report confirms, as a result of the experiments carried on at several receiving stations, the satisfactory results obtained from employing the method of auricular reception.

One of the strong points of wireless in connection with aircraft in war-time is its instantaneity. A recent description contributed to one of our daily contemporaries illustrates this point rather aptly when dealing with a "maiden shoot" with an aeroplane. Mr. Mill Eyron, who contributes the account, makes the comment that the average battery just out from England is exceedingly keen on the prospect of shooting at the Hun, with a friendly eye on the watch, six or seven thousand feet overhead, to report how each round falls and what the target looks like.

After successfully dealing with two targets the observer switches on to a third --a couple of lorries standing in the yard of a farm utilised for a German billet.

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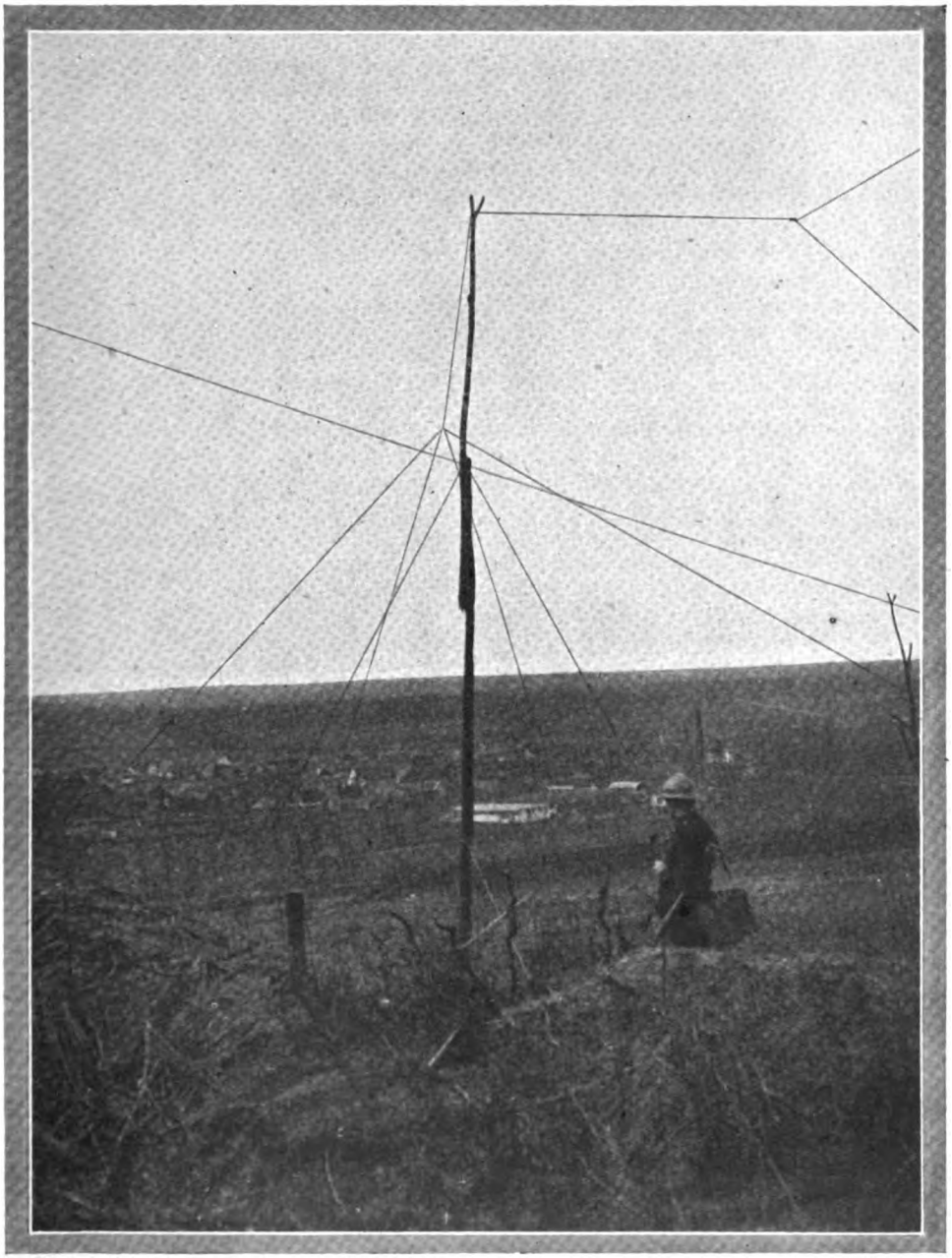

Newspaper Illustrations.] [*French Official Photo.*

A FRENCH FIELD WIRELESS IN THE VOSGES.

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" The first three rounds went to the right and over. I rattled out the correction, ' asked them to try again, and waited anxiously for the lorries to crawl out of the " yard and back to safety. But nothing happened. The fourth round fell further " away from the target and on our side of it. ' Over-estimated your error,' I " murmured, and sent down a correction which, if followed out to the letter, would " put the next round about forty feet away from the yard where the two lorries " were standing.

" As I touched the key to give the ' Fire ! ' signal I glanced at the target, and " saw one of the lorries move. That ' Fire ' was about the quickest thing I had ' ever done with a wireless key. Almost simultaneously with my signal I caught " the flash of all four guns out of the corner of my eye.

" The second lorry in the back of the yard got it ' in the neck ' and disappeared " in a sheet of flame and smoke. The other, blazing like a bonfire, but apparently " only winged, continued moving, then ran into a haystack, which it set on fire, " and the lorry shared its fate. . . . I turned to the key and sent down the equivalent " for a ' bull.' "

A Noble Message.

Radiotelegraphy has to its credit a number of touching messages transmitted through its medium ; we have on various occasions referred to some of these in THE WIRELESS WORLD. But few messages transmitted by the ether waves can vie for dignity and altruistic patriotism with one which was recently projected from the wireless stations of the French Government. Readers will remember that patriotic Poles, fired by the promise of freedom for their country, which formed the subject of one of the early proclamations of the late Czar Nicholas, organised fighting forces through compatriots, many of which have performed heroic deeds in the course of the four years of war. After the Treaty of Brest-Litovsk, when the Bolshevik Government betrayed so many of those who had trusted them, a number of officers and men belonging to the Austrian Polish Legion endeavoured to escape from Prussia, in order to fight side by side with the Allies against Germany. These Polish patriots did not succeed and are now being tried by court-martial at Marmaros-Sziger. Polish circles are doing their utmost to save the lives of these splendid fellows ; but the Legionaries themselves, fearful lest the cause of their Fatherland may suffer, and the negotiations which have been set on foot, addressed to the Polish Club in Vienna a stirring letter, the text of which has been radiated into the ether from French Government stations. The high-minded tone of these devoted men may be gauged from the following extract :—

WAGON WIRELESS, SOMEWHERE IN THE EAST.

" Our country, enslaved and mar-

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" tyred, called upon us to do our duty at the dawn of this world-wide war. It is " with anxiety that we learn now that fear for our fate may weaken the formidable " opposition and the determined attitude of the official Polish representatives in " the Parliaments of the Central Empires. It appears that in order to obtain a " slight alleviation of our yoke the Polish Clubs may be led to limit the opposition " and to make concessions in the sphere of political life in general.

" We appreciate very highly the affection of our compatriots, and we are deeply " touched to see that the country is thinking of us, but we wish to enter an energetic " protest against any commutation of our sentences or any concessions obtained " to the detriment of La Patrie, and by any renunciation of the imprescriptible rights " of the nation."

TRULY AMERICAN.

A certain pungency of flavour frequently characterises the idiom of the young American " knut," and this flavour naturally possesses a good deal of attractiveness for us on this side. We recently noticed in the pages of one of our American contemporaries an account of a wireless operator's submarine adventure which aptly illustrates our point. The breeziness of diction is truly American, and so is the gallantry displayed.

The reporter starts by telling us that "Edwin W. Vogel, the eighteen-year-old boy " who was wireless man on board the *Carolina*, is constructed on the plan of the hour " glass, in that he is wide at the shoulders, lean at the waist, and amply provided " with sand." He was half dressed when his comrade, Harry Werner, brought the warning that a schooner was torpedoed near-by, and he does not shrink from telling us the exact sartorial stage at which he found himself :

" As soon as I got the cups to my ears I caught the schooner's signal over again, " sent Werner to warn the captain and the ship's course was changed right away.

" I had a snack brought up to me, and was sitting eating it and still listening-in, " when a shell plopped across our bows. I squinted out and saw the ' sub ' hauled right alongside. I could hear the passengers bundling up on deck. I yelled to " Werner to go and find out our position from the captain or one of the officers, and " sent our first call out, giving our name and the fact that the Dutchman was shooting. " By the time I had sent it twice, two more shells had gone whistling over us. It " wasn't my business to figure out whether we were to be allowed to leave the vessel " or whether we were to be sunk outright. My job was to send. I kept right on " shooting out the distress message and yelling for somebody to give me the position.

" Presently Werner came in and said that the Dutchman had hailed us by " megaphone and said I must stop sending. I told Werner that I wasn't taking " orders from any skipper but my own and to get me my orders from Captain Barbour. " He disappeared, and after I had sent the signal once or twice over again he came " back with the captain behind him.

" ' You can stop sending, " Sparks," ' said the captain. The cups were still at " my ears and I didn't hear him perfectly, so he shouted it over again, and added, " ' That is an order.' Then I stood up from my chair and stepped away from the " machine, and the captain directed me to leave the house in case a shell might find " its way in on us.

" But even after I had come out on deck a few more shells were sent sailing " over the ship, I imagine, to knock out the aerials if possible. However, they cut " that out by the time the decks were lined with our passengers and crew."

Vogel is a New Yorker and has been a wireless operator two years. His profession has had a fascination for him since he was a child, and when he was a schoolboy he installed an amateur's set on the roof of his home. He studied at the Marconi Institute, graduating two years ago. We have had frequently during the past few years to record the deeds of gallantry executed by our own operators and we welcome the opportunity of recording an instance of the *sang froid* shown by our cousins in times of peril.

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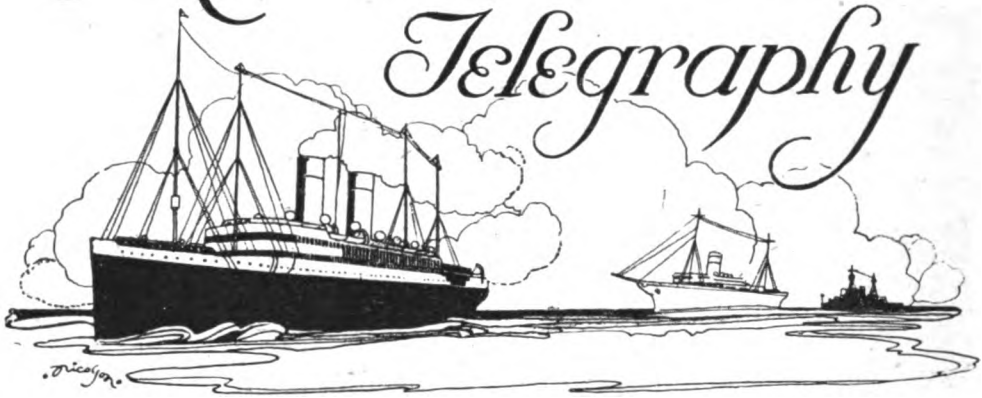
Maritime Wireless Telegraphy



A Wireless Bureau for U-Boats.

Towards the latter half of 1916 Lord Northcliffe visited Spain and astounded the British public by his revelations of the success of Hun propaganda in Spain. From the little fortified city of Pampeluna, in the northern section of the Iberian Peninsula, he addressed a series of articles to the *Times*, giving full details of the way in which the Germans utilised their practised skill in "Wireless" (and other) propaganda work to capture public opinion there. The great journalist—for whether we like his methods or not, we must grant him that epithet—produced at the time a considerable effect. But the public memory is ephemeral and the lethargy of Foreign Office officialism is eternal! The ripples of the stirred water died away, and once more, undisturbed by public opinion, Foreign Office officials settled down to enjoy, in the midst of the national crisis, their "superior" ease and devotion to the cult of indifferentism.

* * * * * *

At the beginning of August, 1918, Lord Northcliffe cast a fresh bomb at them. He published in the *Times* an article from his "Special Correspondent" at Santander, one of the principal seaports in Northern Spain. That article set out full details of the visit of the German submarine U56 to Santander at the close of May last, and called public attention to the fact that her captain, Commander Reisser, together with a petty officer and four skilled mechanics, were allowed to remain at large in the city on *parole*. What does *parole* mean to a German? Merely fresh opportunities for committing acts of perfidy. The Teutonic seaman, ex-officer of the Hamburg-American Line, and *ipso facto* familiar with Spanish conditions and officials, hired within a few hundred yards of the submarine a house which possesses the attraction of complete isolation from other buildings. Following on the conclusion of these arrangements, signalling seawards became a matter of frequent occurrence, an "electric projector of great power" was used, and two illicit wireless transmitters were detected continually sending messages in cypher. A crop of murderous outrages of the same type as that of the *Llandovery Castle* immediately developed in the neighbouring seas. The *Times* correspondent further enunciated the deliberate opinion that this German submarine of antiquated type, comparatively useless for active operations, came into Santander and got herself interned on purpose that her skilled commander might, through the tolerance of the Spanish authorities,

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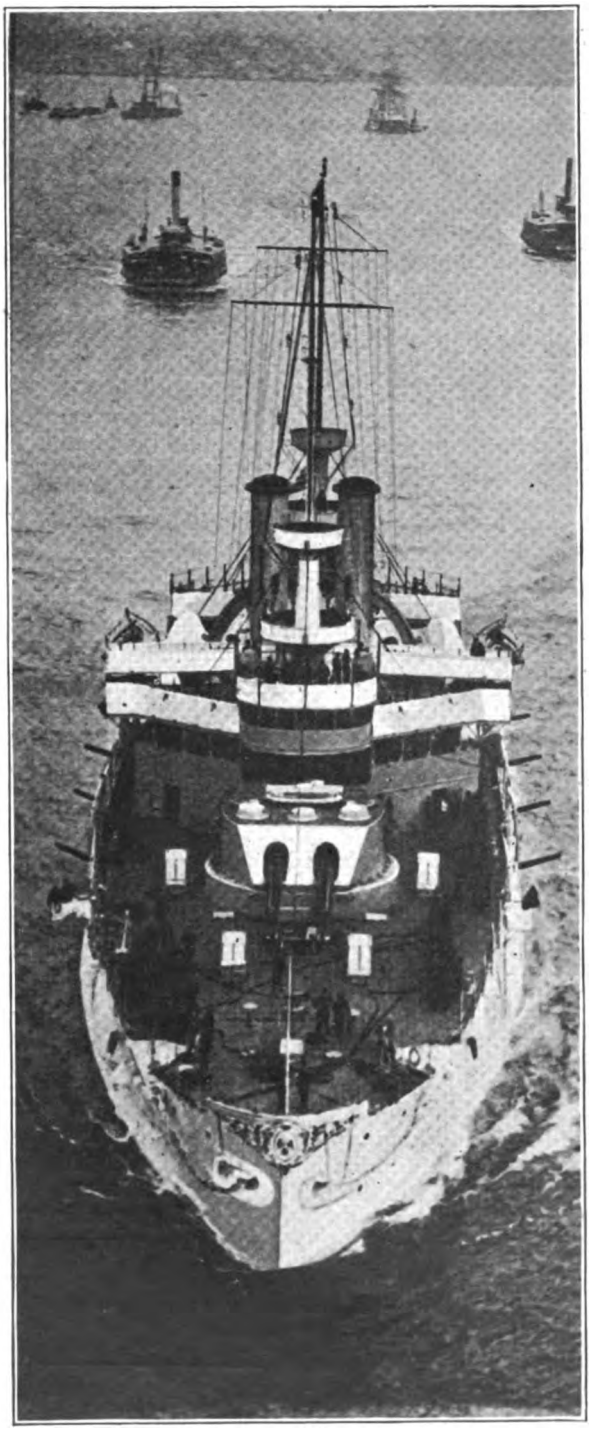
be allowed an opportunity of setting up a wireless bureau of information for the benefit of Hun pirates. The officials of the British Foreign Office were too busily engaged in stifling public opinion and promoting "neutral" interests to trouble about taking diplomatic action on behalf of the nation whom they are supposed to serve, and Lord Northcliffe's correspondent sums up the situation in Spain in the following pregnant phrase :—

"This Santander incident "is only one of many things "which have been, and are "being, bungled or neglected; "millions of British money (to "say nothing of British lives) "involved in our shipping trade "with Santander alone are "allowed to remain in jeopardy, "whilst the German Ambas- "sador takes his family for a "afternoon excursion to see "the submarine, and to con- "gratulate the commander on "the work he is doing for the "Fatherland! It is not the "Spanish Government that is "to blame . . . they quite "naturally follow the line of "least resistance. Hitherto "pressure has all come from "the German side."

There are a number of Spaniards who are perfectly well aware that Spain's interests and development are linked with the cause of the Allies and not with that of the Central Powers. But these people receive no help and little encouragement from British officialdom.

* * * * *

A week after the story from Santander had appeared in the pages of our daily contemporary, together with a



U.S.A. BATTLESHIP IN NEW YORK HARBOUR.

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leading article referring thereto, we read the following announcement dated from Madrid :—

"According to a newspaper despatch from Santander, the captain of the "German submarine U56 has left for Madrid to be interned at Alcala de Henares."

Let us hope that the wireless installations and bureau for the information of pirates have also disappeared. But it will be well for those who sometimes rail against what they are pleased to call "Government by Newspapers" to remember this sequence of events when they are contemplating future diatribes on the same lines.

In common fairness we may add that an official announcement has been finally made to the effect that :

"It was owing to the representations made by the British Government that the "captain of the German submarine interned at Santander has been sent to Alcala "in New Castille."

So far so good ; but nowadays, we must remember, the State professes to direct private enterprise, and indeed actually does so in many directions. Certain Departments of State, however, would appear not yet to have broken with the old traditions of being goaded into taking action by the weight of public opinion or by the enterprise of the Press.

RADIOTELEPHONY AT SEA.

A recent report of the British Chamber of Commerce in Spain, quoted by several of our daily contemporaries, narrates details of wireless telephony trials carried out between the steamships *Raimundo Lulio* at Barcelona and the *Rey Jaime* I during the voyage of the latter vessel between Barcelona and Palma, the capital city of the Balearic Isles. Communication was effected a few hours after she had left Barcelona.

The voices of the captain and officer of the *Rey Jaime* I were audible not only on board the *Raimundo Lulio*, but also at land telephone stations in Barcelona. Quite a number of operators at work in wireless stations on Montjuich, Barcelona, as well as those on board the cruiser *Princesa de Asturias*, are said to have been surprised at hearing the human voice breaking in upon their regular Morse Code telegraphy.

These Spanish experiments are interesting, but so far as we can judge from the reports that we have seen, they do not appear to have established anything very novel ; the human voice, transmitted through the medium of ether waves, has obtruded itself upon the attention of wireless operators at considerably longer distances from the transmitting station than those referred to in the report of the British Chamber of Commerce in Spain. It is quite simple for operators manipulating apparatus attuned to the same average wave-length as that employed by the telephony transmitters to receive such ether wave telephonic communications, although absence of specialised apparatus may prevent their responding through the same medium. Conversational wireless of this character might or might not interfere with Morse Code reception ; but anyhow, the latter would make itself heard through the telephonic speech. Dr. Alfred N. Goldsmith, in his recently published volume on radiotelephony (reviewed in THE WIRELESS WORLD for July), deals very lucidly with "selective" problems, devoting specific consideration and exposition to the fairly sharp conflict between the requirement of loud signals and extreme selectivity.

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Notes of the Month

Fisheries and Wireless.

A paragraph recently appeared in the *Manchester Guardian* stating that in order "to give their fishermen the best chances of a good catch, the Swedish Government has resolved to fit the fishing boats with a wireless installation at a cheap price." At first, according to our contemporary, it is only intended that receiving apparatus should be supplied, so that fishermen may obtain messages from the Government ship, which mothers the fishing fleet, informing them of the movements of the shoals of their finny prey. Such a vessel has been for some years past engaged in supervising the Swedish fishermen at work off the west coast of Sweden, and it is apparently to vessels engaged in these waters that the above-mentioned measure is intended to apply.

Prior to the war, a start had been made with the fitment of British steam trawlers with wireless, and the experiment had proved a striking success. The mother-boats were able—thanks to their possession of transmitting as well as receiving gear—not merely to supervise the actual fishing, but to keep in touch with their owners on land, and record the result of their operations at sea. Thus, immediately on their return, the packers ashore were ready to handle the catch, and to transport the fish rapidly to market.

With regard to what has happened with the British fishing fleet since the initiation of hostilities, it is impossible to deal; but from time to time the Admiralty allows the circulation of paragraphs dealing with British trawlers, which serve to indicate that the utility of radiotelegraphy to such vessels has been too clearly demonstrated for them to be allowed to lack this valuable means of communication when the days of peace arrive.

U.S.A. War Measures.

In accordance with a recent proclamation issued by President Wilson, the date of July 31st was fixed as that on which the taking over by the U.S.A. Government of the telegraph and telephone cables and wireless system would come into effect. We notice also from the American Official Bulletin No. 357 that Mr. Wilson has delegated to the Governor of the Panama Canal authority to exercise, within the territory and waters of the Canal zone, all the powers mentioned in Section 1, under Title II, of the Act of Congress approved on June 15th, 1917, and commonly known as the Espionage Act.

Films by Wireless.

Readers will remember that in Volume III. of The Wireless World we published a series of articles from the pen of Mr. Marcus J. Martin on the subject of "Wireless Transmission of Photographs," which have since been issued in book form under the same title. The principle only requires extension to cover the further development of application to film transmission, and it is interesting to note that, speaking at a meeting of the members of the Stoll Picture Theatre Club in London, Mr. Low Warren, one of the pioneers of the cinematograph industry, predicted that ere long this branch of photography would be linked with wireless. Were such a process to be devised, we might see pictorial representations of great events in New York, Johannesburg, Bombay, or Melbourne reproduced on the screen in London the day after they had taken place. Wireless is emphatically *the* wonder-worker of the twentieth century.

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A Loss to France.

We notice in the announcements made by the *Journal Télégraphique* a paragraph advising the death of M. Victor Belugon, Chief Engineer of the Telegraphs of France, which recently occurred after a long illness. M. Belugon had represented France at the Radiotelegraphic Conference of London in 1913.

War Calls Off Patent Litigation.

At the request of the Navy Department, litigation in the United States Circuit Court of Appeals in San Francisco, involving the Marconi Wireless Telegraph Company's patents, has been ordered to be suspended for the duration of the war. At the request of Attorney Samuel Knight, representing the Marconi Company, and Hiram Johnson, Jun., appearing for the Kilbourne and Clark Manufacturing Company, which Marconi charges with infringement of patents, the cases were taken from the Calendar. Two days, May 22nd and 23rd, had been set aside by the Circuit Court Judges for hearing arguments in the cases. The Government now is using the Marconi patents.

An Aerogram for Vienna

It is appropriate that the homeland of wireless should have been responsible for a message of truth to the Viennese. The wonderful flight recently carried through by Gabriele D'Annunzio, in one of those aeroplanes the progress of which is so closely linked with wireless telegraphy, constitutes a real triumph for human intrepidity over the obstacles imposed by nature. Seven hundred miles separated the poet and his companions from their goal. The journey involved two crossings of the snowy Alps and a double negotiation of the perilous northern extremity of the stormy Adriatic. Two previous attempts had been given up on account of climatic conditions. In these regions Nature almost seems to have done her best to forbid flying. Nevertheless, animated by the same indomitable spirit which enabled the great scientist to solve the secret mysteries of ether, the poet emerged victorious from a contest with the powers of air. He bore a message the keynote of which is struck in the words :—

GABRIELE D'ANNUNZIO

"People of Vienna, you have the reputa-
"tion of being intelligent, but why have you
"draped yourselves in Prussian uniform ?"

And who is Gabriele D'Annunzio ? "An embodiment of the spirit of Italy" would be the correct reply. As poet and dramatist, long before the start of the cataclysm of war, he created a new Italian literature, and has affected the language of his country more profoundly than anyone since Dante.* A reckless enthusiast for liberty, he had for a period transferred his home to France. Italy's entry into the war brought him back, aflame with ardour ; he has participated in numerous naval dashes on Pola, Austria's greatest naval fortified base, and now, at 54 years of age, he regularly commands a squadron of picked young airmen.

* His literary abilities, like all other items of his striking personality, have been placed at the disposa of his country. Many of our readers will doubtless recall the two noble prayers, one for citizens and one for soldiers, which he recited at the Scala at Milan, on the occasion of a war-loan campaign, on June 20th, 1916. The magnificence of the imagery and language employed therein ranks these as priceless contributions to the contemporary literature of Italy.

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Mechanical Analogies to Inductively Coupled Electric Circuits

By H. M. BROWNING

III.

In the previous articles, experiments with pendulums having equal lengths and bob masses and either lengths or masses unequal have been explained and photographs shown. Also the theory has been given which shows the close analogy between pendulums with equal masses and lengths and circuits having equal periods.

Theory was also given in Article II. (page 256, August, 1918) for pendulums with both masses and lengths unequal, and a curious case was noted when the heavy mass was on the short length. Then, the curve as shown dotted in Fig. 9, Article II., has a minimum at about 5 per cent. coupling—*i.e.*, the number of vibrations in a beat cycle at the beginning would be about 7 and these would increase to 18 at 5 per cent. and then fall off gradually as the coupling increased. It will be shown that experiment upholds this striking prediction of the theory.

This article also describes how tuning is necessary in order to pick up messages sent out by wireless stations.

Experiments with Masses and Lengths both Unequal.

In order to get traces with pendulums of different lengths, we had to make a rising stool to carry one board. This board had to be narrow and placed so that

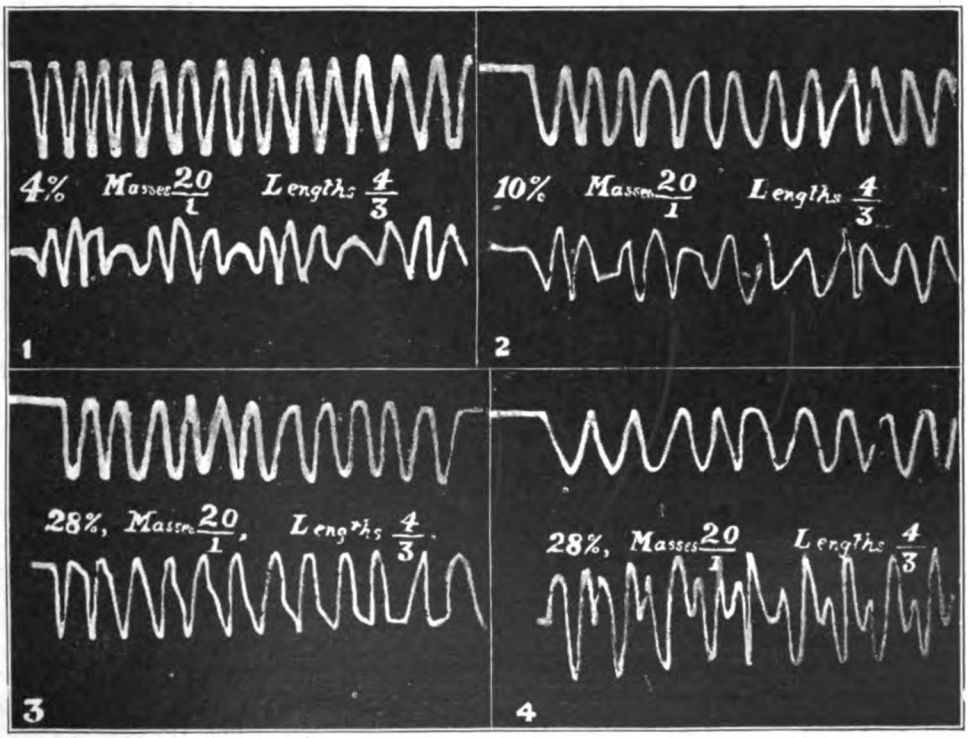

FIG. 13.

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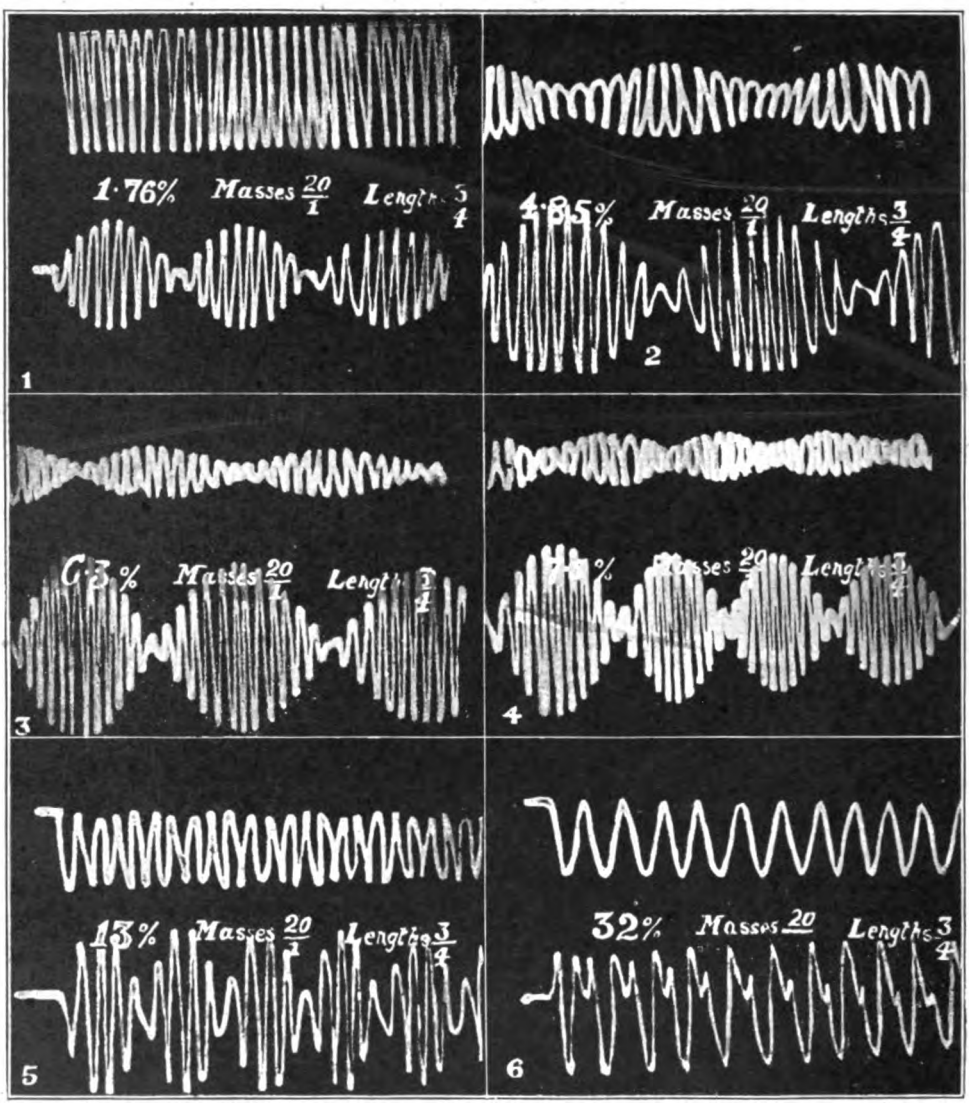

FIG. 14.

the other pendulum did not hit it during its swing. After taking the traces, the stool was carefully removed and the board placed on the lower carriage in the right position and photographed.

In all the experiments the masses of the bobs were as 20 : 1. The lengths of the pendulums were in two cases as 4 : 3 or, to put this in acoustical terms, they were out of tune at the beginning by about a tone and a quarter. In the first case the light bob was on the short length and in the second the heavy bob was on it.

Other photographs were taken with pendulum lengths as 9 : 8 but these have not been reproduced here as they only show an intermediate stage and are of little interest as they only differ slightly from the photographs in Fig. 10, Article II., for traces with pendulum masses 20 : 1 and lengths equal.

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Photographs 1–4, Fig. 13, show traces taken with the heavy bob on the long length. It is noticeable that the heavy bob gives little of its energy to the light bob and that the latter's amplitude for loose couplings is not very great and waxes and wanes very quickly. Further, the number of vibrations in a beat cycle rapidly diminishes until at 30 per cent. coupling the ratio of the frequencies is 2 : 1. At this coupling, with lengths equal and the same ratio of masses, the frequency ratio was also 2 : 1 and the curves obtained were almost identical with photograph 4, Fig. 13.

The traces taken with the heavy bob on the short length are obtained when the heavy bob is drawn aside and the light bob either allowed to hang in its more or less displaced position, or held at rest undisplaced. The accompanying table shows the ratio of the frequencies and the amplitudes for couplings up to 30 per cent., as they were obtained theoretically.

Coupling $=\gamma$ Per Cent.	Frequency Ratio $p : q$	Ratio of Heavy Bob	Amplitudes Light Bob
0	1·154	α	Indeterminate
1·76	1·106	104·6	−0·809
3·37	1·07	12·9	—
4·85	1·054	2·283	−0·893
6·3	1·065	—	—
7·5	1·09	0·2875	−0·836
12·97	1·243	0·0696	−0·640
31·47	1·952	—	—

It is noticeable that with couplings between 2 and 13 per cent. (see photographs 2–4, Fig. 14), the fluctuations of amplitude of the heavy bob are distinctly marked, especially about 6 per cent. In this case the heavy bob gives up nearly all its energy to the light bob, which then attains an amplitude more than three times that with which the heavy bob was started. For very small or very large couplings there is very little fluctuation of amplitude in the vibration of the heavy bob. This is expected from the table and is shown by experiment in photographs 1, 5 and 6 of Fig. 14.

Considering the question of the ratio (p/q) of the frequencies of the superposed vibrations and the variation of this ratio with coupling, it is seen that when the coupling is zero, the ratio naturally has that value which applies to the pendulums when separate. When the bobs are equal and lengths unequal, or when both lengths and bobs are unequal and the light bob on the short suspension, the value of the ratio (p/q) increases with coupling until it almost merges into the value for the lengths equal (see Fig. 9, Article II.).

On the other hand, when the bobs are unequal as well as the lengths, but the heavy bob is on the short pendulum, a new feature is theoretically predicted (see table). Thus when the coupling is gradually increased from zero, the value of p/q should at first diminish, reach a minimum and then increase. These striking features are to a first approximation upheld by the experiments. For as seen in passing along photographs 1–6, Fig. 14, the number of vibrations in the beat cycle at first increases and then decreases. The maximum number of vibration in the cycle is about 13 and occurs in photograph 3, Fig. 14, for a coupling of 6·3 per cent. As mentioned in the introduction, theory predicted a maximum number of vibrations equal to 18 at about 5 per cent. coupling. This slight discrepancy may be easily accounted for by the presence of the sand in the funnels and the possible error in measuring the lengths of the simple pendulums equivalent to those in use. Photograph 6 shows traces with 32 per cent. coupling, which gives a ratio of p/q almost equal to 2 : 1 or a tone and its octave.

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As mentioned in the previous article, this case is analogous to a wireless transmitter with a large self-induction and a small capacity and period and a receiver with small self-induction and large capacity and period. Further, the mechanical case appears to point to the greater efficiency in energy of response of a receiver if bob masses and lengths are unequal and the coupling rightly chosen. For in no other arrangement has the amplitude of vibrations in the receiver reached three times that with which those in the transmitter are started.

A Simple Resonance Experiment.

It is perhaps difficult to understand why a wireless receiver cannot at once pick up any wave which is in the ether; or, on the other hand, how, if the receiver must be in tune with the transmitter, that resonating state can be quickly found. A simple mechanical experiment may be performed to illustrate this. A wire is stretched horizontally between two posts about 5 feet above the ground as illustrated in Fig. 15. Two pendulums are suspended from it, one made by a heavy iron ball on a light cord and the other by a light celluloid or cork bob on a cord with a tightener so that it may be raised or lowered at will. Behind each bob is a horizontal scale, perpendicular to the wire.

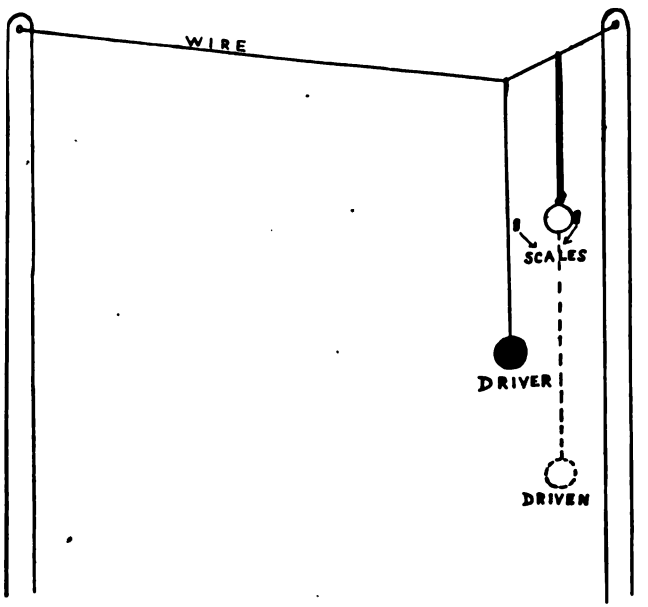

FIG. 15.

The pendulum with the light bob is first made considerably shorter than the one with the heavy bob. The latter is drawn slightly aside and allowed to oscillate in a plane perpendicular to the direction of the wire; this causes the other pendulum to oscillate with, at first, two superposed vibrations. These are to be expected from the theory and experiments explained in the articles on coupled vibrations. The damping, however, is so great that after about six oscillations the quicker vibration has died out and the light pendulum executes simple harmonic vibrations of the longer period only.

When the pendulum with the light bob is swinging with a constant amplitude, its amplitude and also that of the heavy bob are read on the scales, and their ratio is calculated It is noticeable that when the driven is much shorter than the driver the two pendulums are in phase—*i.e.*, they move together in the same direction.

The suspension of the driven pendulum is then lengthened and another set of observations taken. It is found that the ratio of the amplitudes increases, until when the two pendulums are about the same length, the ratio is a maximum, and the phase difference between the vibrations is 90°. When the driven pendulum is further increased in length the ratio of amplitudes again decreases and the phase difference alters until the bobs are moving in opposite directions.

Three types of light bob may be used, a cork ball and large or small celluloid balls, and from tables of ratios of amplitudes, curves may be plotted. The form

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of curve obtained would be similar to those shown in Fig. 16. Here, however, the light bob was always kept the same length and the heavy bob altered. The curves show how the bob with greatest damping (small celluloid) has a wide range of resonance but not very great strength. The bob with slight damping has a strong sharp resonance, which, however, quickly diminishes on either side of the maximum.

Thus our two doubts are answered. The receiver can only pick up waves which are near its own frequency, as shown by the cork bob, and can only respond well if the periods are identical. But if the receiver is highly damped it can show some response for a wide range, and so it is easy to get on the borderline of response and then tune to maximum energy.

The experiments described in these articles were done in conjunction with Professor E. H. Barton, D.Sc., F.R.S., of University College, Nottingham,* whose assistance in compiling these papers has been invaluable.

Nottingham, July 6th, 1918.

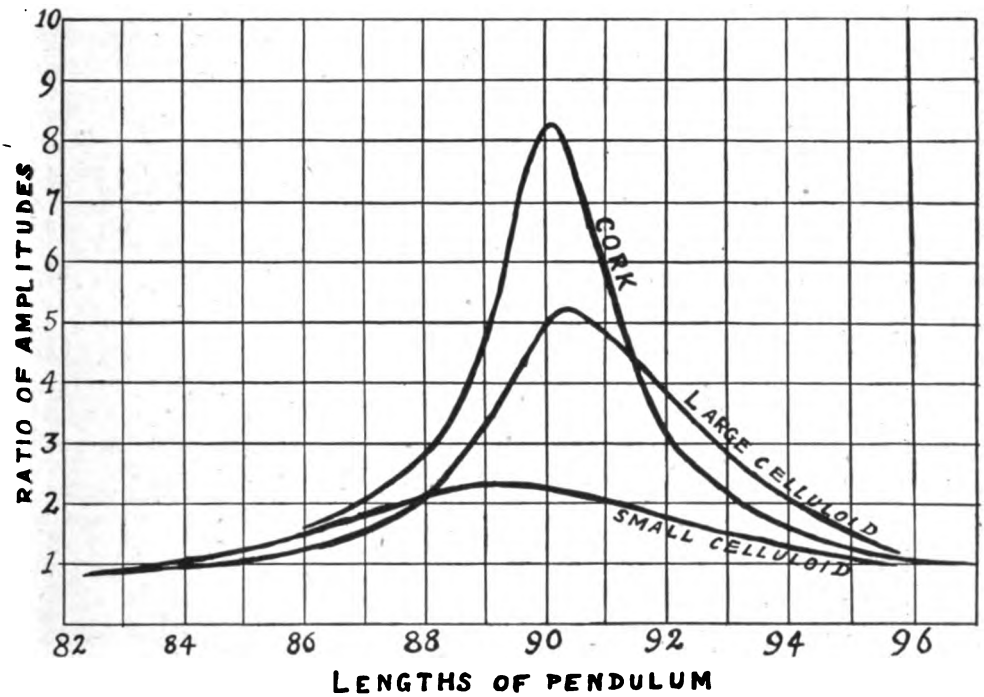

FIG. 16.

Canadian Wireless Extension.

THE trustees of the late Lord Rhondda are contemplating linking-up Peace River, Fort Vermilion and Fort Smith on the Lower Athabasca River, Edmonton, Alberta, by a series of wireless stations at these places. The Dominion Government will be asked for its sanction, and to contribute £9,000 towards the scheme.—*The Contract Journal.*

* For further details see *Phil. Mag.*, October, 1917, January, February and July, 1918.

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Among the Operators

*It is our sad duty, month by month, to record the death of the brave operators who have lost their lives at sea, by enemy action and other causes, in the wireless service of their country. Owing to the necessity of preventing the leakage of information likely to assist our adversaries, the names of ships and localities of action cannot be published. With the exception of Operators Cunliffe and King, who died from natural causes, and of Operator Crosby, prisoner of war in the hands of the enemy, the lives of the operators mentioned this month have been sacrificed as the result of hostile activities. Both on our own part and on that of our numerous readers, we extend to the parents and relatives if these young men, who so nobly upheld the "wireless tradition," the deepest sympathy on their sad bereavement.**

MR. GEORGE ERNEST HAWKES, formerly employed as a clerk by Messrs. Beaufoy & Co., South Lambeth, and later by the Direct Spanish Telegraph Company, was born at Leyton on January 17th, 1897. He was educated at Buckhurst Hill Board School, and Salway College, Leytonstone, and trained at the British School of Telegraphy, Ltd., London, where he qualified for the P.M.G. Certificate, being appointed to the operating staff of the Marconi Company on February 15th, 1914.

Born at London on September 7th, 1899, MR. EDGAR ALLAN DAVIES was educated at "Acland" Central School, Fortress Road, Kentish Town. His experience as junior mechanic at the G.P.O. Factory, Holloway, and later as a messenger in Marconi House, was to his advantage. Trained at Marconi House School, he received the P.M.G. Certificate, and was given an operating appointment by the Marconi Company on August 13th, 1916.

MR. ARTHUR HAROLD TURNER was born at Timperley, Cheshire, on October 30th, 1899, and went to Wadham House School, Hale, Cheshire, and later to Bowden College for his education. Commencing his career with Messrs. Christopher Schorrock & Co., Ltd., Cotton Manufacturers and Merchants, of Darwen, he subsequently underwent a course of training at the City School of Wireless Telegraphy, Ltd., Manchester, and obtained the P.M.G. Certificate. Mr. Turner's service with the Marconi Company commenced in March this year.

A Cambridge man, MR. DONALD RALPH KIRKMAN, eighteen years of age, was a pupil at the Cambridge and County School, and after leaving school was employed by Messrs. Favell, Ellis and Kirkman, Sanitary Engineers, as clerk and typist. His training in wireless telegraphy was given at Marconi House School, where he gained the P.M.G. Certificate, after which he was placed on the operating staff at the end of January in the present year.

MR. EDMUND CUNLIFFE first saw the light at Lees, near Oldham, on August 26th, 1900, and received his education at Derker Council School, Oldham, and the Butts C.E. School, Leigh. He also attended class at the Manchester Evening School of Commerce. The first situation held by him was in the offices of Messrs. Mather and Platt, Ltd., Engineers, Newton Heath, which he relinquished to undergo training at the City School of Wireless Telegraphy, Ltd., Manchester. After he became possessed of the P.M.G. Certificate he proceeded to sea in the Marconi Company's service last March.

Previously employed in the drawing office of the British Thomson Houston Company, Willesden, MR. HORACE ROBERT KINGSCOTE KING was born at Peckham on October 26th, 1899, and educated at Watford Higher Elementary School. He

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* *A Correction.*—Owing to the initial letter of the Christian name in each case being identical, and the fact that the ship on which each had served was torpedoed, we regret that John Fleming Drummond was, in our August issue, erroneously reported lost. James, his brother, was the one whose life was sacrificed, notice of whom will appear in the next issue.

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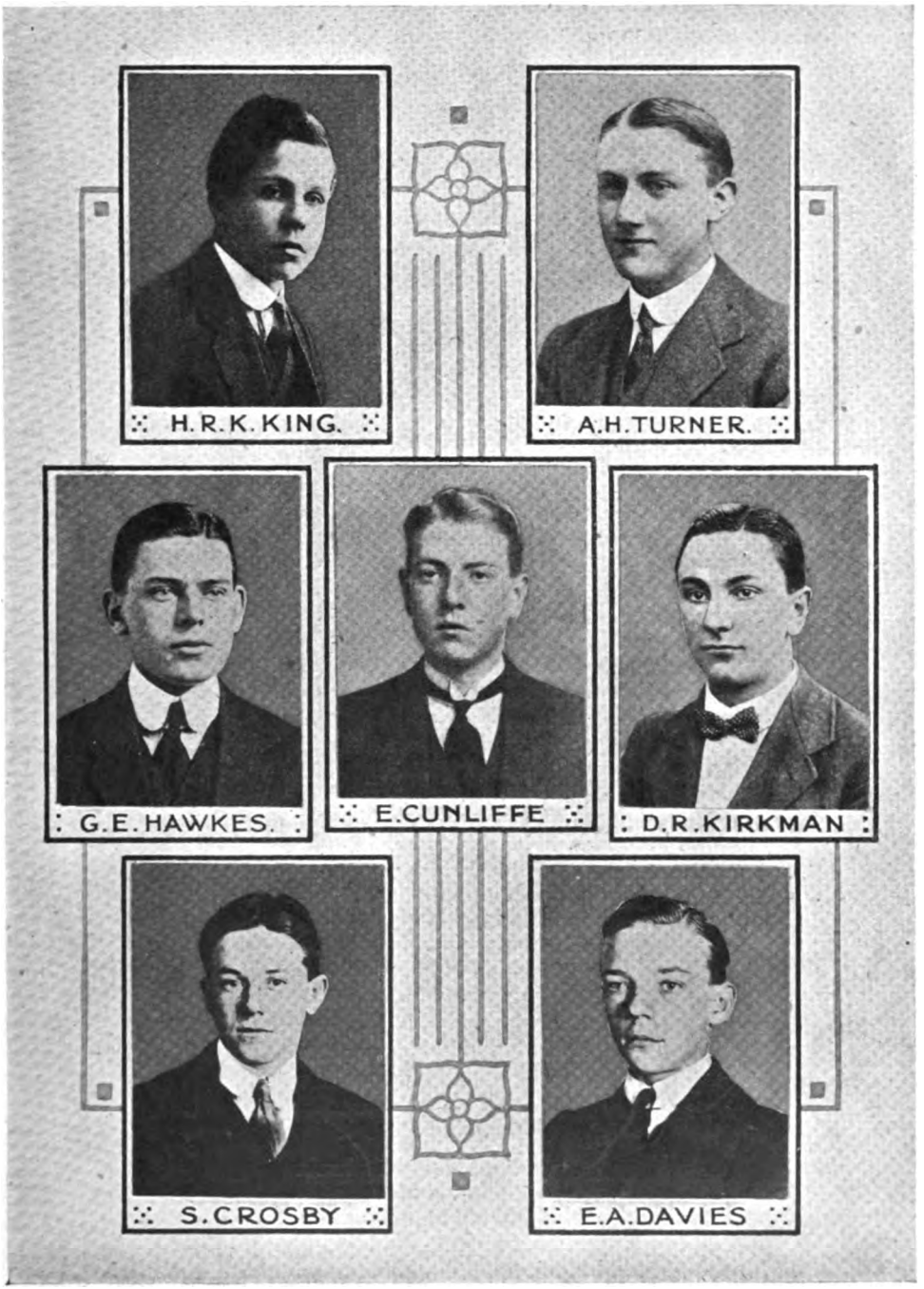
ROLL OF HONOUR.



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was admitted to Marconi House School, where he took the course of training in wireless telegraphy, and was granted the P.M.G. Certificate by examination. Mr. King was placed on the sea-going staff on September 30th, 1917.

We regret to hear that MR. SYDNEY CROSBY has been captured by the enemy, and is now a prisoner in Germany. Mr. Crosby is a Warrington man, and has been in the service of the Marconi Company since June 23rd, 1913. It is possible that he may be interned in the same camp as other of the Marconi Company's operators are detained, and, if so, he will be amongst friends though surrounded by enemies.

The R.N.V.R. Wireless and Signals Club

An Interesting New Venture and Its Journalistic Adjunct.

DOVER is the centre of many activities which it would for the present be indiscreet to attempt to describe. But it is also the scene of an organisation which may become the pioneer of an important movement. Everyone knows the vast developments which have taken place in the organisation of wireless since the start of the war; but not everyone realises the numerical magnitude of the staff engaged in working it. The growth of the Dover patrol caused many of the young men located there to realise the inadequacy of social relaxation and recreation available to them. The result has been the organisation of an R.N.V.R. Wireless and Signals Club, located at 33, Liverpool Street, Dover, the inaugural ceremony of which was conducted by Vice-Admiral Sir Roger Keyes on Tuesday, July 16th last. The club premises contain a large and well-furnished recreation room, billiard room, library, etc. Although a large part of the credit of organisation belongs to the Wireless Section, membership is not confined thereto, all men of the Dover Patrol being eligible.

A quite remarkable amount of energy and enthusiasm has been thrown into the new movement, and one might have thought that the achievement of establishing such a club would have sufficed; but, no! they must run a magazine also. In its present stage, the latter (which appears monthly) is worked off on the Roneo and has only a circulation of 200; but it is hoped that by Christmas, 1918, it may be possible to collect a number of the best drawings and articles in the magazine and make them up into a printed Christmas souvenir number of everlasting interest to R.N.V.R. men. The Editor, who has favoured us with specimen copies, would like prospective contributors or subscribers to communicate with him at the above address. Poetry seems a strong point of the new venture, and the August number contains a happy travesty on the well-known song of "The Rosary," the opening verses of which run:

"The hours I spent tuning your spark
Are as a thousand years to me;
With so much lag or so much lead,
My Rotary—my Rotary.

The product of Marconi's brain
Oh wonderful thou art to see.
I love to list to thy refrain,
My Rotary—my Rotary.

Thy note had cadence, sweet and high
In giving G, or merely D,
And if required, an I.M.I.,
My Rotary—my Rotary."

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Instructional Article

NEW SERIES (No. 6).

EDITORIAL NOTE.—Below we give the sixth of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

ENERGY.

As he reads about wireless telegraphy the student will constantly come upon references to energy—the energy of a charged condenser, the energy in the aerial, and so on. What *is* this intangible thing called energy which is so carefully considered by the engineer? From the standpoint of physics it is probably the most important quantity in the world—namely, **the ability to do work.** In an earlier article it was stated that for the physicist there are but two real *things*, matter and energy, because these only are conserved. By this is meant, of course, that we *know* of only two such entities. The law of conservation as explained in the case of matter applies equally to energy, which cannot be created or destroyed, its sum total remaining constant, although its nature suffers change according to the conditions obtaining in any particular system. It is, perhaps, difficult to dissociate from one's mind the idea that if anything has physical existence it must be *material*, but such an idea springs from too narrow an interpretation of the word physical. An attempt should be made to regard energy simply as a constant natural agent, changeable but indestructible, which is perceptible by its effects and which, in most cases, is measurable as work or capacity for work. There is no *direct* proof of its existence for the simple reason that our senses permit us to be *directly* aware of matter only.

In any case of the transformation of energy from one form to another, or, what is the same thing, any case of work, we lose some energy in the process. For example, in the case of a motor car some of the chemical energy of the explosion is changed into the mechanical energy which moves the car; nevertheless a certain amount of the energy of the explosion is changed into heat which often may be instrumental in *stopping* the car. *Energy lost is not destroyed but has been converted into forms in which, generally, it is no longer available for useful work.* It still plays its part in the economy of nature but is not at our immediate disposal.

We defined energy as the ability to do work, and, as it is measured in units of work, energy and work may be considered as practically interchangeable terms, so that "work done" may be read as "energy transformed."

Potential Energy.—This is the name given to energy which is due to *position*. The commonest example of this is that possessed by a body which has been raised to a height. The elevation of the body is the result of work being done on it—by a man's muscles, for instance; as a result of this the body has **potential energy**—that is, it is capable of giving back the work done on itself. It can be caused to actuate a clock or to draw up a bucket of water, or, if allowed simply to fall back to earth it will do work on the air and on that part of the earth which it strikes. A stretched elastic body is a good example of the storage of potential energy.

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When a boy fires a catapult the work he does on the elastic when he stretches it is in turn done by the elastic on the bullet. In the case of an elevated body—

$$\text{Potential energy} = mgh,$$

m being its mass, h the height to which it is raised, and g the acceleration. When the body falls mgh absolute units of work will be done.

The energy in a charged condenser is measured in terms of the *work done by raising the potential difference between the plates*, the formula being $\mathbf{E = \frac{1}{2}QV}$ **ergs,** where Q is the charge expressed in electrostatic units and V the potential in e.s. units. It should be noted in comparison that the *capacity* of a condenser is quite a different quantity—namely, the ratio of the amount of electricity stored in it to the potential at which it is stored; or $C = \frac{Q}{V}$. The capacity of a given condenser is constant but the energy in it is directly proportional to the square of the charge and inversely proportional to the capacity.

A charged condenser, then, possesses electrostatic (or potential) energy by virtue of the work done in charging it, and in order that the system can give back work the charge *must move*; when it does so the electrostatic energy is transformed into electrokinetic energy.

Kinetic Energy.—This is the energy due to motion. A rifle bullet in flight, for example, has kinetic energy, its work being done on the air and on whatever it strikes. If a force F displaces from a position of rest a mass m through a distance d, the work done by F is Fd. (See section on Work.) If this work is not done against any external resistance, we can say that it is stored in m as kinetic energy. $\mathbf{F = ma,}$ hence the kinetic energy of the mass after displacement is mad, which can be shown to be equal to $\frac{\mathbf{mv^2}}{\mathbf{2}}$, the kinetic energy of a body in absolute units.

The C.G.S. unit of energy is the erg. (See Work.)

The **dimensional unit** of energy is the same as that of Work, being as shown above, Force × Displacement or $[\mathbf{ML^2T^{-2}}]$.

It is particularly relevant to the study of wireless telegraphy to note that potential energy is convertible into kinetic energy, and *vice versa*. When a body falls from a height its potential energy (which it possesses by reason of its elevation) is changed into kinetic energy which increases proportionately to the decrease of the potential energy. When the body strikes the earth the kinetic energy is transferred to its component particles and to those of the immediate region where it strikes, because its impact causes an increase in the velocity of these particles; in other words, the energy is transformed into heat. In the reverse case of a body being thrown to a height its energy changes from the kinetic to the potential form, the former decreasing as the velocity decreases, and the latter increasing as the kinetic energy decreases.

The oscillatory discharge of a condenser should be familiar as an example of rapid cyclical changes of electrical energy from one form to another. While the condenser is charged its energy is electrostatic but immediately its positive and negative terminals are connected through an inductive circuit of low resistance this energy commences to change into the kinetic energy of the moving charge. By virtue of the inductance of the circuit oscillations are set up so that the condenser is quickly discharged and then recharged with the original positive plate now negative, and at this point the energy has again assumed the static form. This alternating process continues until all the energy has been used up, some in the form of heat and the rest as radiated electromagnetic waves.

RESISTANCE.

It has been pointed out that although energy is capacity for doing work in no case are we able to utilise the whole energy of a body or system. This is because of the resistance against which the work is done. Resistance in its various forms

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dissipates energy and if on this account it is an evil it is at the same time, generally speaking, a most necessary evil and must not be regarded as the enemy of man even though his existence under present conditions depends upon available energy. Were it not for the resistance of the air a falling raindrop could kill a man as surely as a bullet; without resistance the electric filament lamp and electric heating would not be present possibilities and brakes on wheels would be useless.

The relation of energy to resistance can be summed up by saying that **where there is no resistance there can be no work done,** which makes it clear that although resistance appears to waste energy it is only by virtue of it that energy can be utilised. Just as friction is really a friend in disguise—without it we could not even walk—so resistance in an electrical circuit is essential to the employment of the current. In the case of a steady E.M.F. applied to an inductive circuit, if the resistance of the circuit were zero, the current would grow infinitely slowly, whereas by an increase of the resistance it would be enabled to reach its final value much quicker, although with any increase of resistance the final value of the current is lowered. In the **induction coil** there is an example of a circuit which is required to be rapidly responsive to "make and break" of current, and, as the inductance is large, we have to make the *resistance as great as possible* in order that the current may reach its final value in a minimum of time; the resistance is, however, limited in actual practice to some value which will enable us to obtain the necessary current for working. $\left(C = \frac{E}{R}\right)$

INERTIA.

This has already been defined as that property of matter which opposes change of movement, and which, once movement has begun, opposes its acceleration (positive *or negative*) and cessation. For more advanced studies, especially in connection with the electron theory, clear ideas about inertia will be found particularly helpful. A sharp distinction exists between resistance and inertia although in certain of their effects they may appear to be alike. Resistance *wastes* energy whereas inertia *stores* energy, and, which is equally important, delivers it up again, not in an irrelevant and harmful form such as heat, but in the same form and to the same body or system. By the loose employment of the word in everyday speech there has become largely current the idea that inertia is akin to laziness and that it only opposes a change from rest to motion. On the contrary, inertia is a tendency towards *uniformity of motion*. When a train begins to move the propelling force has to overcome the inertia of the *mass* of the train, which is opposing the start. When it is necessary for the train to stop and the steam is shut off, it continues to move for a considerable time, because **energy is being delivered back** to it by reason of its inertia. When, as is generally the case, there is enough of this stored energy available to carry the train past the platform some method has to be used in order to divert some of it into another system; this is accomplished by the application of the brakes, and the surplus energy is literally thrown away in the form of the heat of friction—another example of the fact that resistance, although a waster of energy, is extremely useful on some occasions.

The statement that a body has inertia may be understood to mean that before the body can move it must be endowed with energy and before it can stop moving that energy must be taken from it.

In considering the phenomenon of self-induction we can push our ideas of inertia a step further. Self-induction is often defined as electrical inertia and in the light of what has been written above this definition would seem to imply that electricity is considered to be a form of matter, inasmuch as if it exhibits the property of inertia it must possess mass. To a certain extent this conclusion is correct though it is perhaps better to say that scientists regard *all* mass as electrical. The student should bear in mind that our sole avenues of direct approach to the study of nature

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are the five senses and he must not adopt, even for the rigorous demands of exact science, the point of view that only those things exist which are discoverable to his senses; physics often calls for *a posteriori* reasoning. When we see like effects it is safe to assume like causes. We do not ascribe the fall of a meteorite to a certain cause and that of an autumn leaf to another, nor do we imagine that iron and lead sink in water for entirely different reasons. Similarly, if the properties of two bodies are identical in number and nature, we conclude that both are composed of the same material.

Inertia is one of the properties of mass which are common to matter in all its forms, whether solid, liquid, or gaseous, whether we consider a single atom or the Pyramids; in fact, inertia is so fundamental that no form of matter, as we understand matter, can be thought of as existing without it. If, then, we observe in some system *effects* similar to those of inertia, but no sensible movement of matter, we may at least infer that there exists in that system something the *inertia* of which produces the observed effects. When an electric current flows through an inductive circuit, we find opposition to the *starting and stopping* of the current, opposition to an *increase or decrease* of current, the *storage and subsequent release of energy*, and a time effect which certainly cannot be accounted for by the joulean resistance alone. The conclusion is that there is associated with the circuit when an E.M.F. is applied to it something *moving*, which has inertia and therefore mass, but which is not material in the ordinary sense of the word, but *ultra-atomic*. We have arrived at that point where we are confronted with the idea of mass without matter.

The student knows that all round a moving charge of electricity (*i.e.*, a current) there is a field of energy, and he also knows that when the charge ceases to move the field of energy disappears. Putting this into the words we used above we can say that before a charge can move it must be endowed with energy and before it can stop that energy must be taken from it. This, as explained above, is what is meant by the possession of inertia.

This subtle entity which has mass and inertia but which is not matter is called an *electron*. Here we must leave the subject, having purposely introduced ideas a little in advance of the general nature of these articles in order to demonstrate the value of elementary physics as an aid to the study of electrical theory and to suggest to the reader a new angle from which to view the phenomena of electromagnetism.

STRESS, STRAIN, ELASTICITY.

STRESS.

This is a quantity referred to chiefly in mechanical work but to which there is an analogy in electricity. We can clear the ground by giving it the more familiar name of force. In mechanics, then, there are recognised, amongst others, forces or stresses which tend to elongate, to compress, to bend, or to twist the material to which they are applied. A stress which tends to elongate, such as a longitudinal pull on a rope or an aerial wire, is called a **tensile stress.** When materials are tested in order to find out how much *pull* they will stand before breaking it is their **tensile strength** which is measured. The other three forms of stress mentioned do not seem to need further explanation.

Note that an electrically charged body exerts **electric force** in the space surrounding it, and that in the region of a magnetic pole there is a field of **magnetic force.**

Units.—Stress is measured by such units as **one pound per square inch** or (C.G.S.) **one dyne per sq. cm.,** or generally, by the **force per unit area**; hence the **dimensional unit of stress** is

$$\frac{\text{Force}}{\text{Area}}=\left[\frac{MLT^{-2}}{L^2}\right]=\left[\frac{MT^{-2}}{L}\right]=[\mathbf{ML^{-1}T^{-2}}].$$

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STRAIN.

Strain is produced by stress. When a body is subjected to a mechanical stress and undergoes an alteration of size or shape the alteration per unit dimension is a measure of the strain in it. To take a simple case, suppose a piece of rope is stretched; its length is increased and the strain in the rope is *the ratio of the alteration in length to the original length.* The strain in this case is longitudinal, as it would also be in the case of a body acted upon by a force which caused it to become *shorter.* If a body is subjected to an uniform stress over its entire surface the resulting strain is volumetric.

$$\text{Volumetric strain} = \frac{\text{Change in volume}}{\text{Original volume}}.$$

Up to a certain limit strains are proportional to the stresses which produce them (Hooke's Law), the stage at which the law breaks down being followed in the case of ductile materials by one at which a small increase of stress produces a large increase in the strain.

Strain has **no dimensions.**

ELASTICITY.

If a rod of steel and a piece of rubber of equal dimensions are stretched so that each becomes a millimetre longer the stretching force exerted on the steel will have to be much greater than that exerted on the rubber. Now, the elasticity of a material is measured by the ratio of the stress which has to be applied to it in order to produce a certain strain to the strain produced.

$$\text{Elasticity} = \frac{\text{Stress}}{\text{Strain}}.$$

Strain is the alteration per unit dimension and in the case we took is represented by a change in length of 1 mm., so that if for the sake of clearness we assume that the force applied to the steel rod is 400 times greater than that applied to the rubber, we have

Rubber. $\quad \frac{\text{Stress}}{\text{Strain}} = \frac{1}{1} = 1.$

Steel. $\quad \frac{\text{Stress}}{\text{Strain}} = \frac{400}{1} = 400.$

It should be apparent from this result that steel is far more elastic than rubber. Calling elasticity e, stress S and strain s, if $e = \frac{S}{s}$ then the strain is proportional to the stress, and inversely proportional to the elasticity; hence to produce a certain strain the greater the elasticity of the material the greater is the force required.

In the case of a longitudinal alteration—*i.e.*, increase *or decrease* of length—the ratio of stress to strain is known as **Young's modulus,** being a constant for a given material. The following is a complete explanation of how it is calculated.

$$\frac{\textit{Stress}}{\textit{Strain}} = \frac{\textit{Force applied} \div \textit{Area of cross section}}{\textit{Alteration in length} \div \textit{Original length}} = \frac{\textit{Force} \times \textit{Original length}}{\textit{Area} \times \textit{Alteration in length}}.$$

Young's modulus is expressed in convenient units of stress per unit area and a few interesting examples are here given.

Indiarubber,	Young's	modulus	= 32	tons	per square inch
Steel (mild)	,,	,,	=13,500	,,	,,
Phosphor-bronze	,,	,,	= 6,000	,,	,,
Copper	,,	,,	= 6,200	,,	,,
Glass	,,	,,	= 4,000	,,	,,
Brass	,,	,,	= 5,700	,,	,,
Wood	,,	,,	= 700	,,	,,

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The outstanding property of an elastic body is that any deformation it suffers under stress disappears when the stress is removed provided that the latter has not increased beyond a certain limit. If this **elastic limit** is passed the body may break or will not perfectly re-assume its original shape or size. It will be seen that as a rule the more elastic materials such as steel or phosphor-bronze have much lower elastic limits than the less elastic substances like rubber or wood.

In considering stress and strain in electrical actions, we are led first to the subject of electrostatics which is outside our present scope. We will, however, deal briefly with a few points of interest to that class of student for which these articles are specially written.

From the statement that a charged body exerts electric force in the space around it, it follows that *the seat of the strain* produced by that force or stress *is the medium across which inductive action takes place.* Hence, if a charged conductor were caused to induce another charge in a second conductor we should expect some form of strain to exist in the space between the two wires. A *moving* charge does *not* exert electric force but gives rise to a field of *magnetic flux*, the direction of which is at right angles to that of the motion of the charge. Therefore, if the static charge in the first conductor should move we ought to find that *the dielectric strain disappears as the electric force is removed*, **because of the elasticity of the dielectric.** By the time the potential energy of the static charge has become wholly transformed into the kinetic energy of the moving charge *all* the strain in the dielectric should have disappeared. Also, if the electric force should be such that it strains the dielectric beyond its elastic limit that dielectric should demonstrate the fact in some way or other. At this point it is necessary to have recourse to diagrams and special conceptions.

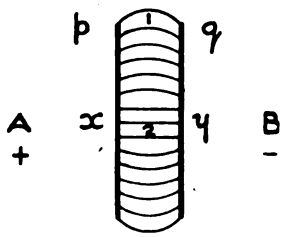

FIG. 27.

It is customary to represent the field of a charged body or the field between two charged bodies by a number of lines, some of them straight and perhaps some curved, as in Fig. 27, in which the plates *A* and *B* are oppositely charged.* Now it is really important to realise that these lines exist only on paper—that is, they are not physical things, a phrase which the reader ought to appreciate fully after what has been written previously about conservation. In view of certain facts scientists may have admitted that the question of the objective existence of such lines admits of discussion, but the acquisition of a working set of ideas about electric and magnetic fields would be rendered more difficult if we were to attempt to follow the discussion. The lines are not filaments in the æther but just imaginary lines made visible for the purpose of assisting the mind to grasp the theory of the part played by a dielectric in the storage or transference of energy. It would be quite legitimate to represent the force of gravity acting on a suspended weight by lines drawn from the weight to the earth, but the lines would only represent the direction in which the force acts and not any peculiar state of the air or other medium. In most diagrams in any book the number of lines shown bears no special relation to the number which would be considered to exist theoretically, unless the contrary is stated; further, it must be understood that in diagrams such as Fig. 27 only one *plane* is shown, whereas the actual field cannot be limited in practice to a single plane.

Let us fix our attention upon the line *xy* in Fig. 27. It is typical of all the other straight lines and represents *the direction in which a free positive charge placed at any*

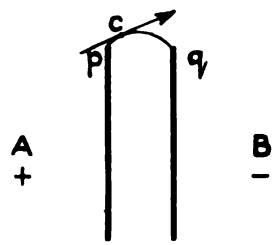

FIG. 28.

* The figure shows only the edges or side elevations of the plates.

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point on it would tend to move. It stands for nothing else. In this particular case such a free charge would be urged towards the plate B, in a direction normal to the surface of A—*i.e.*, $x \rightarrow y$. If the charges on the plates were reversed so that A became negative the *direction* would remain the same but the sense would be reversed and a free positive charge would tend to move towards the plate A—*i.e.*, $y \rightarrow x$. In the case of a curved line such as pq the direction of the force at any point on it is given by the tangent of the curve at that point. Fig. 28 illustrates this, the *direction* of the force at the point c being that of the tangent, the *sense* being shown by the arrow. The reason why some of the lines are curved will appear later.

Up to this point we have considered the field between A and B as a field of force, taking into account only its action on a free positive charge; hence while we are dealing with this aspect of the field the lines are called **lines of force.** There is, however, another way of regarding the field, in which the *strain* in the dielectric is brought into prominence. The function of the dielectric in a case such as Fig. 27 represents, where we have static charges only, is to store energy. We say that for a certain applied force there occurs a certain displacement of electricity across the dielectric; the greater this displacement the greater the strain—*i.e.*, the charge on the plates is, for a given dielectric, a measure of the strain in the intervening medium, and also of the stored energy. If the charge is sufficiently increased the dielectric breaks down under the strain and some of the strain-energy is transformed into light and heat. Such a breakdown takes place when the potential difference between the electrodes of an induction coil reaches a critical value and a spark passes. In this case the dielectric, air, is self-restoring, but in a condenser with glass plates the rupture of the dielectric is an inconvenience which the practical wireless man studies to prevent.

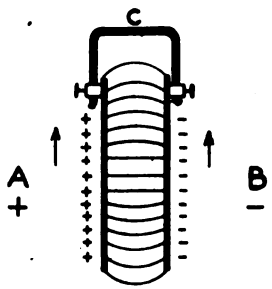

FIG. 29.

We can represent the strain by a diagram similar to Fig. 27, with the lines of induction coinciding with the lines of force, the difference in the name being an indication of the way in which we are dealing with the field. The nature of the strain is generally considered to be such that these lines tend to contract longitudinally—that is, to become shorter and thicker and to repel each other laterally. Besides explaining the phenomenon of mutual attraction between the plates this brings us to the explanation of the reason why some are drawn curved. It should be clear that the line xy (Fig. 27) tends to remain straight because it bears an equal pressure or repelling force on both sides of it,* whereas the outlying lines, notably pq, having more pressure on one side than on the other, bulge outwards. The student is warned not to accept in too material a sense explanations and diagrams relating to what are only conceptions. He should devote his attention to the significance of the lines as drawn and to the reasons why they are drawn in certain ways. For example, it is important to see that as the lines succeed each other outwards in Fig. 27, and become more curved, *there are fewer of them passing through an unit area of the field*, because the field near 1 (see fig.) is weaker than in the region of xy at 2; also, near 1 the field is not uniform. At every point on the line pq there is a different *direction.* Now the curvature and distribution of the lines in the figure graphically express the facts contained in the two latter sentences.

(*To be continued.*)

* We say *both* sides because we are considering a single plane—that of the paper.

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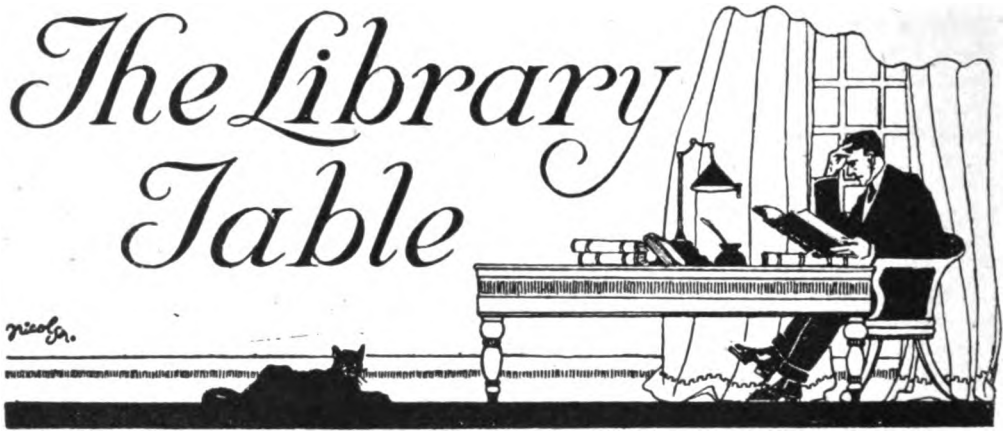
The Library Table



WIRELESS TELEGRAPHY AND TELEPHONY. By W. H. Eccles, D.Sc. Second Edition. London: Benn Bros., Ltd. 22s. net.

Dr. Eccles's excellent handbook, which was first published in 1916, has gained a well-deserved popularity, and the new edition, which now appears after considerable delay, will be welcomed in many quarters. Following in the main the lines laid down in the previous edition, the new volume shows evidence of careful revision and will be found to contain a considerable proportion of new matter. Thus the thermionic valve, which has come into such wide use in recent years, is now treated much more fully, both in relation to its use as a detector and as a transmitter. Other additions include descriptions of the Arlington and Darien stations of the American Government (taken from the *Proceedings* of the Institute of Radio Engineers) and some further details regarding the Marconi and Telefunken systems. The excellent paper of Dr. de Groot (already published in THE WIRELESS WORLD) is also drawn upon, and the section devoted to High Frequency Generators has been augmented. Under "Wireless Telephony" some new matter regarding valves has been added, thus bringing this section into line with modern progress.

The Glossary, to which barely half a dozen terms have been added, might, we think, be improved by the addition of a number of terms now in common use. For example, we find no reference to "dynatron" and "pliodynatron," instruments to which reference is made in other parts of the book; and although Dr. Eccles may be strictly accurate in his definition of "Motor Generator" as "a motor-driven dynamo taking D.C. at one voltage at the motor terminals and delivering it at another voltage at the generator terminals," it should be pointed out that this term is largely treated as synonymous with "Motor Alternator." The definition of "key" might also be happier.

In respect of a minor matter it may perhaps be worth while to call the attention of the publishers to a slight discrepancy. In the description of the Marconi system the diagram on p. 389 shows a crystal detector used with an intermediate circuit, although this arrangement is not used in any standard Marconi receiver; and a few pages before this, under "The Marconi Transmitter," the transformer leads are shown taken to the condenser. This method has not been used for some years, the leads being now taken to the discharger, thus placing the inductance of the chokes in series with the jigger and tuning inductance, when charging.

The publishers are to be congratulated on the new "format" of the volume, which is now made up as an ordinary textbook. The previous edition, with its semi-limp cover and rounded corners, had the appearance of a pocket-book without

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its portability. Now that this "make up" is discarded the book falls well in line with other similar publications.

It is unfortunate that the photographic illustrations are so poorly reproduced. This is apparently due to worn blocks, from the previous editions, being used. Otherwise the book is very well printed.

FLIGHT WITHOUT FORMULÆ. By Commandant Duchene. Translated from the French by John H. Ledeboer, B.A. London: Longmans, Green. 8s. *net.*

Although this book has been on the market for some little time, it is yet particularly welcome at the moment, when popular interest in aviation has reached such a high level. The schoolboy of to-day is no longer content to speak of monoplanes, and biplanes, as such—to refer to aircraft in these terms would be looked upon as a proof of ignorance. One has only to listen to popular conversations of the day to see how widespread is the detailed knowledge of the subject. A speck in the sky will be identified as a Handley-Page, by the beating note of the engine, the observer remarking in casual tones that his taste lies in the direction of a Bristol Scout. Heated debate may then follow on the merits or demerits of a Sopwith "Pup." Such popular knowledge, however, is usually rather shallow, and although many people can distinguish the differences in type, there are few others than "professionals" who understand the basic principle of flight.

The approach to this branch of the subject is usually barred to those without considerable mathematical knowledge. The average aviation textbook is a mass of formulæ and equations, but formidable as these may seem to the uninitiated, they are yet nothing but the "shorthand" of calculation, and rapidly lose their fearsomeness on approach. The fact remains, however, that many people have a distaste for mathematics, and more lack the requisite knowledge. To this large class the book under review is dedicated.

Although throughout the work not one single formula appears, the author has yet been able to explain in clear and easily understandable language the whole of the underlying principles of the subject. Speed, Power, Lift, Longitudinal and Lateral Stability, the effect of wind, the principles of the propeller, and every other branch of flying theory, are handled in a masterly manner; the use of mathematics (except in a carefully disguised fashion) being avoided to a degree which will come as a shock to those who believe that nothing worth mentioning in aviation theory can be taught without a mass of formulæ.

The immense debt which aviation owes to M. Eiffel is well brought out in this book. Scarcely a page can be turned without finding some reference to this great French investigator's work, and we are glad that this acknowledgment is so fully given.

We can recommend this volume to all who, while wishing to acquire a somewhat deeper knowledge of flying than can be gathered from the usual popular textbooks, are yet loth to have recourse to mathematical studies.

Share Market Report

LONDON, *August 20th*, 1918.

BUSINESS has been very active in the shares of the Marconi Group during the past month. The very satisfactory meeting of the Parent Company brought in large investment buying, and all classes of shares show a marked advance in price. The closing prices as we go to press are: Marconi Ordinary, £4 3s. 9d. (*ex. div.*); Marconi Preference, £3 11s. 3d. (*ex div.*); American Marconi, £1 10s.; Canadian Marconi, 14s. 9d.; Spanish and General Trust, 11s. 9d.; Marconi International Marine, £3.

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Personal Notes

Messengers' Prize Day.

The Third Annual Distribution of Prizes in connection with the London County Council Classes for the Marconi Company's Telegraph Messengers took place at the Wild Street Schools, Kingsway, on Friday, July 19th, 1918, at 2 p.m. Mr. Beresford Ingram, Chief Inspector of the London County Council Educational Department, who was introduced by Mr. C. Metcalf, Responsible Master, occupied the chair. He opened the proceedings by a short address to the lads, congratulating them on the standard of their work during the past session, and expressed the hope that they would make an increased effort during the ensuing session. In the absence of the Manager, W. W. Bradfield, Esq., C.B.E., who found it impossible to be present owing to pressure of business, Mr. Rochs, Traffic Manager of Marconi's Wireless Telegraph Company, Limited, distributed the prizes. He also congratulated the boys on their progress and expressed the hope that they would show their appreciation of the efforts of their teachers, of what the Company was doing, and of the opportunities given to them, by showing every attention at classes, and benefiting to the greatest possible extent, of the educational facilities at their disposal. It was satisfactory to note that at least six of the lads obtained 100 per cent. of marks in Arithmetic and that History and Geography, recently added to the curriculum, had found favour with the boys, as no doubt did also the Debates, Lantern Lectures, the Magazine, Cricket and Football Clubs which their teachers had organised.

Mr. Rochs then distributed prizes to fifteen successful students, Messenger A. Whybrow being at the top of the examinations.

Mr. Ingram, in proposing a vote of thanks to Mr. Rochs, mentioned that the lads should consider themselves fortunate in serving a Company taking so keen an interest in their general and educational welfare. The lads responded heartily to this, as well as to a vote of thanks to Mr. Ingram, proposed by Mr. H. C. Gee, Master, who spoke highly of the work done by the boys, and also impressed on them the necessity of improving results next session. After remarks by Mr. A. Law, Inspector, who also urged the boys to respond to the efforts of their teacher, the proceedings terminated. Mr. J. H. Timms, Inspector, Mr. B. H. Matthews, Principal of the Kennington Commercial Institute, and Mr. A. Bisping of the Marconi Company were also among those present.

Obituary.

Second-Lieutenant A. Noel Ealand, R.A.F., who was accidentally killed on July 15th while flying at the Front, was the son of the late Charles Winn Ealand, of Kirkby Lonsdale. He was educated at Shrewsbury and became a solicitor. At the time of his death he was in partnership at Thetford, Norfolk. After serving for two years with the Red Cross in France, he obtained a commission in a Dragoon regiment, but subsequently transferred to the R.A.F. Wireless Section. He married in 1910 Miss E. Augusta Horwood, daughter of Lieut.-Colonel T. Horwood, of Aylesbury, and leaves a widow and three sons.

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We regret to announce the death of MR. ALFRED S. WILLIAMS, Deputy-Chairman of the Royal Mail Steam Packet Company.

Official news has been received by the parents of the death of RICHARD HOLDSWORTH, senior telegraphist (wireless operator), R.N.V.R., of 97 Healey Wood Road, Burnley. When last seen he was trying to rescue his captain, who was badly wounded, and he sank before the rescue boat could reach them. A commander wrote to the parents: "You will find some consolation in the knowledge your "son met his death so nobly."

AWARDS.

The Military Cross has been awarded to TEMPORARY SECOND-LIEUTENANT E. W. PARKIN, R.E. He first served in the ranks of the Royal Horse Guards, and is now attached to the wireless section of the British Mission to the French Army. For two hours under heavy enfilade bombardment Lieutenant Parkin proceeded up and down the front line trenches. It was owing to his gallant conduct that the line was held until reinforcements arrived, when a counter-attack was launched, with the most successful results.

PRIVATE R. D. DAVIES, wireless operator, R.F.A., has been awarded the Military Medal. He obtained his wireless training whilst at Nantyffyllon.

The D.S.O. has been awarded to CAPTAIN AND TEMPORARY MAJOR NOEL HANS HAMILTON, who in civil life was an electrical and wireless engineer.

WIRELESS OPERATOR CHARLES E. MATHER, R.N.V.R., 264 Mulgrave Terrace, Swinton, has been awarded the D.S.M. for distinguished service rendered on a minesweeper which was mined last November. He has since been incapacitated for sea service.

PRISONER OF WAR.

SECOND AIR MECHANIC AND WIRELESS OPERATOR A. K. BOSTOCK, R.A.F., of Hull, missing since May 27th, has now advised his parents that he is detained in a German prison camp, and that he is well and comfortable.

IN ITALY.

MESSRS. DALGETTY NICHOLSSON and A. M. GEO. LESTER, the two wireless operators of the Royal Air Force shown in the accompanying photograph, are doing duty somewhere in Italy. Long hours and discomforts, notably from the effects of lachrymatic gas, do not prevent them from keeping fit and well, and carrying on.

CAPTAIN S. B. BALCOMBE, late of the Traffic Department of Marconi's Wireless Telegraph Company, Limited, lately paid a call on his friends in Marconi House, prior to leaving for the Italian front.

MR. DALGETTY NICHOLSSON AND MR. A. M. GEO. LESTER

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Company Notes

Marconi's Wireless Telegraph Company, Limited

Mr. Godfrey Isaacs on the Recent Action

SHAREHOLDERS' VOTE OF CONFIDENCE

SUBSTANTIAL INCREASE IN THE PROFIT.

THE 21st Ordinary General Meeting of Marconi's Wireless Telegraph Company (Limited) was held on July 31 at the Cannon Street Hotel, under the presidency of Mr. Godfrey C. Isaacs, the deputy-chairman and managing director, who was received with cheers on taking the chair.

The Secretary (Mr. Henry W. Allen, F.C.I.S.) read the notice convening the meeting and the auditors' report.

The Chairman, who was again cheered on rising to address the shareholders, said:—Ladies and gentlemen, in the first instance, I want to tell you that Mr. Marconi extremely regrets that he is unable to be here to-day. Important duties detain him in Italy at the present moment, and he asks you, therefore, to excuse his absence. Our colleague, Mr. Saunders, I am sorry to say, is not in good health, and is thereby prevented from being present. He also asks that he should be excused.

MR. GODFREY ISAACS'S OFFER OF RESIGNATION.

Before proceeding with the ordinary business of the meeting, I wish to express to you my great regret that you should have been inconvenienced last Wednesday by the necessity for the adjournment of this meeting for a week. In sending out the reports and accounts, we had supposed that the action in which I was engaged would have lasted at most three or four days, and, therefore, in fixing the meeting for the 24th, I had contemplated being able to preside. I need not tell you that the possibility of losing this action had never entered my mind, and I will not attempt now to minimise the gravity of the verdict. I have served notice of application for a new trial, which I have every hope of obtaining. You will understand that in these circumstances it is not right that I should now further express myself on the subject of the trial and the verdict. Meantime, I must face a very painful ordeal, but truth has a habit of prevailing, and I feel confident that in the end it will prevail in this case. (Cheers.) For the present, however, I must recognize the position as it now is, and do what I think is right and honourable in the circumstances. I am bound by an agreement to the company to act as its managing director until the end of December, 1925, and the company by that agreement is equally bound to me. I do not think it would be fair or proper on my part to take advantage of that period, and I therefore, before proceeding with the ordinary business of this meeting, unreservedly tender to you my resignation, and offer to terminate my agreement forthwith. (Cries of "No.")

THE BOARD AND THE MANAGING DIRECTOR.

Captain H. RIALL SANKEY, C.B., R.E. (Retired).—Ladies and gentlemen, I beg to move:—"That Mr. Godfrey Isaacs's resignation of his office as managing director of the company be not accepted, and the shareholders present at this meeting, having complete confidence in his honour and integrity, request him to withdraw the same." (Hear, hear.) In support of this resolution, I would tell you that at a board meeting the following resolution was passed: "Resolved, that the board beg leave unanimously to express their sympathy with Mr. Godfrey C. Isaacs as the victim of a totally unexpected verdict, and to affirm their complete confidence in his honour and absolute integrity." (Cheers.) Some years ago, namely, in January, 1910, Mr. Marconi came to me and told me he thought that, at last, he had found the right man to be managing director, and asked me if I would go to see him. I did so, and recommended to Mr. Marconi that Mr. Godfrey Isaacs should be invited to become the managing director of the company. At that time, as the older shareholders will know, the company was in a very difficult position. The overdraft at the bank was £50,000, and I well remember that on one occasion I had to advance the sum of £250 to pay wages. Mr. Isaacs soon made himself felt, but at first he met with great difficulties. He overcame them one by one, and the rate of progress can be judged by the successive annual reports and accounts; and, ladies and gentlemen, if you compare the statement now before you with the condition of things I mentioned at the beginning of these remarks, you will have a true measure of what Mr. Godfrey Isaacs has done for the company and for the shareholders. (Cheers.) The directors and the staff, having every confidence in Mr. Godfrey Isaacs, have backed him to the best of their ability, and they still desire to do so.

A VOTE OF CONFIDENCE.

At all material times both the directors and the staff were fully conversant with all the matters which have recently been before the public, and it is because of that knowledge that they wish to be identified in future with Mr. Isaacs as your managing director. (Cheers.) I will now read the resolution once more, and I shall be glad if some shareholder will then second it:—"That Mr. Godfrey Isaacs's resignation of his office as managing director of the company be not accepted, and the shareholders present at this meeting, having complete confidence in his honour and integrity, request him to withdraw the same."

Mr. G. H. WEST.—Ladies and gentlemen, as a comparatively small shareholder, I have the greatest possible pleasure in seconding this resolution. I may say, and I feel sure that all those present will share that view, that I have, and have always had, the greatest confidence in Mr. Godfrey Isaacs. (Hear, hear.) It is hard enough to find a man to carry on successfully an undertaking like this, but we have happily done so. We have in Mr. Isaacs a man whom it would be impossible to replace, and

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we have every confidence in him, and as there has been no reflection on his honour I have the greatest possible pleasure in seconding the resolution, and I ask you all to support it. (Cheers.)

Mr. J. W. HAMILTON.—In view of the serious charges which were levelled at Mr. Isaacs in the recent action, I maintain you should be told the exact facts brought against him. (Cries of "We have read them" and "Sit down.") I do not wish to say anything to prejudice Mr. Isaacs. (Laughter and "Oh!") He has maintained that he is not guilty, although the jury have given a verdict against him. (A voice.—"What on?") I move that Mr. Isaacs should withdraw from the board until such time as his character is cleared. (Cries of "Vote" and "Sit down.")

THE MANAGING DIRECTOR'S REMUNERATION.

Mr. WALTER KINNEAR.—I do not rise to second the amendment just moved. I feel sure the shareholders have the utmost confidence in Mr. Godfrey Isaacs, our managing director. I, as a shareholder in this company for 16 years, and holding a considerable number of shares, can bear testimony to the very valuable services which he has rendered to the undertaking. The shareholders are under the very greatest debt of gratitude to him, and we are only doing our duty in not making up our minds on the question until he has prosecuted an appeal, as he intends to do, in the matter recently before the Courts. I wish to make only one further observation: Inasmuch as the resolution has the effect of continuing the appointment for a further period of seven years, and in view of the statement which has already been made with regard to the rather handsome terms on which it is alleged the managing director holds his appointment from this company, and also in view of the very large sums of money due to this company for war services during the past four years, apart from the very considerable sum which must come on account of the departure from the "wireless chain," I suggest that before this resolution is passed the shareholders ought to be informed specifically of the terms on which the managing director holds his office.

The HON. D. O'BRIEN.—I should like to say, with reference to what the last speaker said, that I cannot quite see that that has anything to do with the resolution before the meeting. The resolution is, as I understand it, that Mr. Isaacs remains managing director. How has that got anything to do with the resolution before the meeting?

The CHAIRMAN.—Referring to the penultimate shareholder, I should like to state at once that when I agreed with Mr. Marconi to take over the managing directorship of this company, and gave up my business, I agreed to do so on the following terms:—That I should receive a salary of £5,000 per annum, and in addition 5 per cent. on the net profits of the business in each year, whatever they might be. I may just add that at the time I took over the managing directorship there were no profits. ("Hear, hear," and cheers.)

Mr. R. A. SMITH.—I think, after the statement that Mr. Isaacs has made, it will not be necessary for us to go any further into the matter of his remuneration. We have heard from Captain Sankey that when he came into this company the company had an overdraft of £50,000, and you see by the report what its condition is to-day. I suggest it is time the company ceases to be made a sort of Aunt Sally or cockshy of every disgruntled place seeker or unscrupulous politician. (Laughter and cheers.) As a humble shareholder, I most heartily endorse the position the board has taken up with regard to Mr. Isaacs's appointment. (Cheers.)

A "PRACTICALLY UNANIMOUS VOTE."

Captain SANKEY.—I now beg formally to put the motion. (Hear, hear.) You have heard it read twice.

The resolution was carried, amid cheers, with only one dissentient.

Captain SANKEY.—It is very gratifying to have this unanimous, or practically unanimous, vote—only one shareholder against it, and that is also the number of shares he holds in the company. (Laughter.)

The CHAIRMAN.—Ladies and gentlemen, I deeply appreciate this expression of confidence. (Loud and prolonged cheers.) I want to be allowed to add one word more, and I hope you will not consider it ungracious—I think I deserve it. (Cheers.) Now, before proceeding, ladies and gentlemen, I ought to tell you—I think it is due to all of you to know—that Mr. Hamilton, whose is the only dissentient voice, used to be in the employ of the company, and that he is the holder of one share. (Laughter, and cries of "Shame.") Now, gentlemen, I think we might proceed to the business of the day.

Mr. HAMILTON.—That is an improper statement to make. You know that I represent a large number of shareholders.

The CHAIRMAN.—I have no such knowledge; there is no evidence of it.

SENATORE MARCONI'S MESSAGE TO MR. ISAACS.

In the course of the Chairman's subsequent address to the shareholders he was handed the following cable from Senatore Marconi, which he read to the meeting:—"Most deeply regret and deplore verdict. You have my most sincere sympathy, and I can assure you of my firm belief in your honour and integrity." (Cheers.)

The CHAIRMAN.—We will now proceed to the business of the day. Dealing, in the first instance, with figures, there is, if you will look to your balance-sheet, little which calls for comment. The capital account is unchanged. There is a small difference in bills payable and sundry creditors which arises from ordinary fluctuations in the business. The reserve account stands at £1,000,000, which you approved at the last meeting, and to this will be added a further £100,000 if you adopt the recommendations of the board to-day. On the other side there is an increase in the sundry debtors, etc., which is only proportionate to the business of the year. The same remarks apply to stock. The mortgage on one of the freehold works has been further reduced by the annual payment of £1,000, and, therefore, the property stands as an asset at £1,000 in excess of the figure last year. Our other freehold properties have been increased by additional buildings and material amounting in all to some £20,000. The long-distance stations figure at some £8,000 less this year in consequence of the amount written off for depreciation. We then come to the very important item of shares in associated companies and patents. This figure we always bring into our balance-sheet at cost price. It shows an increase over last year of some £95,000. The par value, however, has increased by £210,000. This is a very big item in the accounts, and one which at the present time in particular it is extremely difficult to value, but I can tell you this—it is worth very substantially more than the figure at which it stands in the accounts. In support of this statement I might tell you that shares in three companies which represent a par value of approximately £900,000, or about one-third of our total holdings, are worth to-day substantially over one and a-half millions sterling. (Cheers.) It must not be inferred from this that our remaining shares are of equal value. They, however, represent a

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very considerable sum, and will, I trust, show material improvement with time. The amount represented by patents is included in the figure of £1,400,000; therefore, their total cost is also covered by the shares in the three companies which I have mentioned. Many of the patents are old, but their depreciation is more than compensated for by a large number of new patents.

Turning to the profit and loss account, there is nothing which calls for any comment except that the balance, being profit for the year, shows a substantial increase over last year, and no doubt will be regarded by you as highly satisfactory. (Hear, hear.) If you approve the resolutions which we shall put before you later with regard to the payment of dividends and reserve account, we shall carry forward to next account approximately the same figure as was brought forward from the preceding year. I do not think there is anything else in the matter of accounts which calls for explanation, but I shall later give any shareholder an opportunity of asking questions upon any point on which he may desire further particulars.

The Post Office and the Imperial Chain of Stations.

Now that our action against the Post Office in respect of the Imperial chain of stations has been disposed of in the Courts, I think it is my duty to review shortly the history of this unfortunate contract. You will all remember that it originated by my proposing to the Colonial Office at the beginning of 1910 that they should give us similar rights to those which are given to the cable companies, enabling us to erect for our own account on British soil a chain of stations, eighteen in all, around the world. Had this request been granted, what a sea of trouble the company would have escaped, and what an asset such a chain of stations would have been to the Empire! (Cheers.) However, the Government of the day, whilst approving of my proposal, felt that the stations should be Government owned, and we were invited to build them in partnership with the Government. We, therefore, abstained from building these stations upon foreign soil and gladly accepted the Government's invitation. The Imperial contract was the result. It was completed only after a very long negotiation, and was eventually reduced to six stations. It was, as you know, the subject of attack in the House of Commons, and it was only in August, 1913, that the final contract was entered into and ratified by Parliament. For some unexplained reasons the company was hindered from proceeding with the erection of those stations, and when war broke out in August, 1914, three of them only had been commenced. In September, 1914, there was talk of accelerating the construction of the stations and work was to proceed day and night. At that time the company held that the Government had abandoned the contract, but, having regard to the fact that we were at war, we placed ourselves unreservedly at the disposal of the Government to build the stations with all possible speed, or do whatever the Government desired of us, without wasting time to discuss terms. We were prepared, and so offered to leave ourselves entirely in the hands of the Government to do what was fair.

"A Disingenuous Offer."

For some unexplained reasons, these negotiations were discontinued, and on December 30th, 1914, we were informed that the Government were not going to proceed with the stations at all, as they were no longer required. We had spent, in the meantime, £140,000 odd upon them, and had had a great deal of work and had engaged preparatorily a large staff; further, we had made our whole programme abroad subservient to the Government programme in connection with the Imperial chain of stations. We then asked the Government what it was proposing to do with regard to reimbursing us the very large amount we had expended and agreeing the compensation we should be paid. This resulted in our being offered, three weeks later, the reinstatement of the contract to build the six stations, which, three weeks earlier, the Government had informed us were no longer required. (Laughter, and a voice—"Shame.") It was a disingenuous offer, and one which we could not treat as being honestly made, nor could we believe that it would be honourably carried out. In the circumstances, we felt that the consequences to the company might have been extremely serious, and we were not disposed to take the risk. We were, however, most anxious to avoid the unpleasantnesses which might follow, and therefore proposed that we should enter into a new contract with the Admiralty. Negotiations were accordingly opened, and the Admiralty made us an offer which they stated represented to us the equivalent of the repudiated contract of the Post Office. We were not of that opinion, but so anxious were we to avoid any friction that we agreed to the terms. The draft contract was to be submitted to us immediately. A month later, however, Mr. Asquith's Government gave way to a Coalition Government, and presumably the instructions to the Admiralty were not renewed, for no draft contract was ever forthcoming, and it became clear in the month of November, 1915, that the Admiralty did not intend to proceed with the stations. We had thus lost the best part of a year and were no further, but we were still out of our money. We were obliged eventually to have recourse to a Petition of Right. This we deferred acting upon in consequence of further negotiations, which were commenced with a new Postmaster-General in the hope again that we might be able to agree on terms of a new contract to take the place of the old one. Long negotiations followed, and, although we received an offer, it was one which, acting on your behalf, we did not feel we were justified in accepting. We were willing and even desirous of making a substantial concession for the sake of peace, but we did think we were entitled to, and were bound to insist upon, something approaching what we regarded as a fair arrangement. But this was not forthcoming.

The Petition of Right.

We were still anxious, however, to avoid the Petition of Right going to the Court, and so we offered to go to arbitration provided that the letter of January 21st, 1915, offering the reinstatement of the contract, should be withdrawn. This letter should never have been written, and if it stood would have reduced the damages—and the object of it was to reduce the damages—to which we should have been entitled to such loss as had been occasioned us for the three weeks' delay between the date of the repudiation and the offer of reinstatement. We felt, pending the withdrawal of the letter, this was a matter of such importance that it could only be settled in a Court of Law. The Government, however, could not see its way to withdraw that letter of January 21st, 1915, and consequently the Petition of Right came into Court. There appeared, on behalf of the Crown, the Attorney-General, the Solicitor-General, and Mr. Walter, K.C., and two Treasury juniors. As you now know, after counsel on behalf of the company had opened the company's case for two days, the Attorney-General announced

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that the Government did not propose to proceed with the defence and agreed to the withdrawal of the letter of January 21st, 1915. (Laughter.) I may tell you that no new fact transpired during the proceedings in Court which was not perfectly well known to the Post Office months before we were compelled to go into Court and when we offered arbitration. Why this letter could not have been withdrawn when we made the proposal and the whole matter referred to arbitration a year sooner we are at a total loss to understand. (Hear, hear.) Great waste of valuable time and public money could, and should, have been avoided. Explanations have been given in the House of Commons of the course adopted by the Crown. They appear to have been regarded as satisfactory, and, therefore, I suppose that we are among the exceptions in being totally unable to appreciate them. Judgment, as you know, was given for the company, and the matter has been referred to a referée to assess the damages. A learned Judge has been appointed for this purpose, but I am sorry to say that his time has been so fully occupied that he will not be able to sit until the month of October. There is, however, at last a fair prospect of the matter being disposed of before the end of the present year. I want to assure you that it always has been, and is even now, the desire and wish of your directors to arrive at a reasonable and friendly settlement of this matter, by which the nation could benefit by the stations sooner than pay a very large sum of money in damages with nothing to show for it. (Cheers.) Even at this eleventh hour any reasonable and fair offer would be most willingly accepted by the company. (Hear, hear.)

The Government and the Company's "Invaluable Services."

The position with regard to the other sums due from the Government remains just as it was when we met last year. (Cries of "Shame.") No remuneration or compensation has been received in respect of the invaluable services which the company has rendered. There have been some negotiations, but so far no offer even approaching the sum which the company could reasonably accept has been forthcoming, and one almost begins to despair of being able to obtain a settlement by negotiation and agreement. It does seem to your directors extraordinary that whereas millions and millions of public money have been spent, perhaps not always usefully, for fair remuneration for such valuable services as this company has rendered not one penny piece is forthcoming. Our inventions and patents continue to be used on an immense and ever-increasing scale by the Admiralty, the War Office, and the Royal Air Force. Their incalculable help to the Allied cause is unquestionable—(hear, hear)—but not one farthing in respect of them has the company received. It is true, no doubt, that each of the Government Departments has its hands as full as they can be with matters of far greater consequence, and, therefore, it has not been possible for them to devote time to the adjustment of accounts with the company, and I would be the last to complain of this, but inasmuch as the sums due, even were they calculated at prices substantially less than those agreed upon and actually paid to us in cases where the company has manufactured and supplied, would represent very many hundreds of thousands of pounds, I do think that in common fairness the Government could, and should, have made to the company a substantial payment on account in respect of each of the three Departments concerned, leaving final figures for adjustment, if they will, to the end of the war. (Hear, hear.) But how long are we to wait? When will be the end of the war? Must we wait till then? Without knowing what our financial strength is we cannot, of course, give full scope to our future programme. This disadvantage alone is of considerable consequence, for it quite prevents our shaping a course abroad which we otherwise might do, enabling us the better to prepare to meet enemy competition after the war.

The Absence of Government Co-ordination.

We have to look ahead, as it behoves every British industry to do, and I think we might receive the consideration which is due to us and so help us instead of causing us unnecessary difficulties. But this is not the only way the Government could assist us. I am making no complaint against any particular Government Department or individual. But I do very much complain of the system, or the absence of system. (Hear, hear.) Although wireless is to-day, and will be perhaps more so in the future, a subject of extreme importance, there is, unfortunately, no Government policy, no central authority, no co-ordination between Government Departments, nobody in a position to speak or act on behalf of the Government. What concerns the Foreign Office has no interest for the War Office; what is important to the Admiralty is quite ignored by the Colonial Office. There is, in a word, a total absence of co-ordination and no authority to whom one can apply for any guidance whatsoever. (A voice—"Shame.") Can one conceive such a state of things existing in Germany? One would have thought that after the experience of four years of war it would be recognised that some organisation was imperative, and a definite policy adopted. I am afraid that these remarks may meet with some disapproval, and even perhaps censure from some quarters, but I think it my duty to make them, just as I have thought it a duty to speak on other occasions without paying any heed to the possible consequences to myself. A little plain speaking may be productive of some good resulting both to the country and to the company. (Cheers.)

The Company's Interests in America and Canada.

On the other hand, our interests abroad, on the whole, continue to develop in a satisfactory manner.

In the United States of America a new company has been formed, with the approval of the United States Government, by the Marconi Wireless Telegraph Company of America, with the title of the Pan-American Telegraph and Telephone Company. The object of that company is to erect stations for the purpose of creating a commercial service of wireless telegraphy between North, Central and South America. The shares of the company are held as to 40 per cent. by the Marconi Wireless Telegraph Company of America, as to 20 per cent. by the Federal Telegraph Company, the owners of the Poulsen system interest in the United States of America, and as to 40 per cent. by this company. It is intended to proceed immediately with the erection of high-powered stations. It is satisfactory to know that the Marconi Wireless Telegraph Company of America has declared a dividend of 5 per cent. for the past year, and it is understood that their works have been considerably increased in order to cope with Government orders. The whole of their long-distance and coast wireless stations are under the control of the United States Government for the duration of the war upon terms which have been agreed, and which are regarded by the management as reasonable, and monthly payments are regularly made. (Cheers.)

The Marconi Wireless Telegraph Company (of Canada) (Limited) has made good progress during

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the past year and a fair profit resulted. Before, however, the company can be expected to pay dividends some reorganisation of its capital will be required. This company, as you will remember, was formed a great many years ago with a capital of five million dollars, and practically no working capital was provided. The directors of the company have long desired to reconstruct the company and make certain arrangements with us which would put them in a sound position. We are in full sympathy with them, and are desirous of meeting them in any reasonable proposal. Had it not been for the outbreak of war I should myself have visited Canada some few years ago with this object in view. The matter, however, should not, I think, be longer delayed, and we have invited the Canadian company directors to submit their suggestions. We expect to receive their proposals very shortly, and as soon as they come to hand they will receive early consideration. They already have our good will. (Hear, hear.)

THE AUSTRALIAN, ARGENTINE, SPANISH AND RUSSIAN COMPANIES.

The Australian company, Amalgamated Wireless (Australasia) (Limited), is making excellent progress under the managing direction of Mr. E. T. Fisk and a reconstituted board. I am confident that that company will substantially and successfully develop its business under able management. The Argentine company, the Compañia Marconi de Telegrafia sin Hilos del Rio de la Plata, in consequence of the war has necessarily stood still. The Spanish company, the Compañia Nacional de Telegrafia sin Hilos, is conducting a very substantial telegraph business, and has made excellent arrangements in other directions which give us every reason to hope that the company has now turned the corner and has in front of it a far more satisfactory prospect. (Hear, hear.) The Russian company, the Société Russe de Télégraphes et Téléphones sans Fil, has, of course, been passing through very difficult times. The latest information we have is by letter dated the middle of April of this year. They have, naturally, suffered severely from the difficult labour conditions, but, as far as we gather, have suffered no other harm, and having regard to the importance of wireless telegraphy in Russia, no matter what the Government of the day may be, there are fair grounds for supposing that importance will always be attached to a business such as that of the Russian company. In these and other circumstances which I cannot speak about to-day we have not thought it necessary to make any special reserve in respect of the very considerable sum of money we have invested in Russia.

The Belgian company, the Société Anonyme Internationale de Télégraphie sans Fil, notwithstanding the prevailing conditions, has continued to conduct its business satisfactorily. It has, however, been impossible for the board, other than Captain Sankey and myself, to meet, and therefore no dividends can be paid until circumstances change.

FRENCH AND ITALIAN BUSINESS.

The French company, the Compagnie Française Maritime et Coloniale de Télégraphie sans Fil, has continued to do a good business and has substantially increased its dividend. The Cie Universelle de Télégraphie et de Téléphonie sans Fil, in which we were so largely interested, is now in course of liquidation. The whole of its tangible assets have been sold to a new company, entitled the Cie Générale de Télégraphie sans Fil, a company with a capital of Fcs.12,500,000, the whole of which has been subscribed in cash by about 20 shareholders, amongst which are the French Cable Company (with the approval of the French Government)—I should say that the French Government is interested in the French Cable Company, and it has approved of the French Cable Company taking a substantial part in this new wireless company—the Banque de Paris et des Pays-Bas, Banque Française pour le Commerce et l'Industrie, Banque Transatlantique, Crédit Mobilier Français, Messrs. Jacques Gunsburg et Cie Société Centrale des Banques de Provence, and, again with the approval of the French Government, Marconi's Wireless Telegraph Company (Limited). It has been agreed that we should subscribe for 40 per cent. of the total capital, and this we have done, representing the sum in round figures of Fcs.5,000,000. The liquidation of the Cie Universelle, when complete, will produce to us a sum of approximately Fcs.11,000,000. This is a most satisfactory settlement of one of the most troublesome and difficult positions with which I have ever had to deal. (Hear, hear.) I am confident that under this new *régime* the 40 per cent. of the capital which we now hold in this new French company will produce to us, right away, excellent returns and far more than we ever should have secured through our much larger holding in the Cie Universelle.

I need scarcely say anything with regard to the Marconi International Marine Communication Company (Limited). Every shareholder will have had an opportunity of reading quite recently of the general meeting of that company and will have learned what substantial and satisfactory developments have succeeded each other year after year. Our Italian business has again been of a highly satisfactory nature and most ably directed by the Marquis Solari, our respected representative in Rome.

The Relay Automatic Telephone Company (Limited), in which we have a very large interest, has had its sphere of action very considerably restricted in consequence of the war. It has, however, been able to do some business, notably that of installing its system at Australia House, amongst other large establishments, where it is working to perfection. This company, when war closes, in my opinion, has a great future in front of it; unquestionably automatic telephones will be the order of the day when circumstances change, and there is, I believe, no automatic system so excellent as that of the Relay Automatic Telephone Company (Limited).

"WIRELESS" AND LONG-DISTANCE CABLES.

We have many important negotiations in many parts of the world of which it would not be wise of me to speak to-day, but I think one may fairly contemplate that the business of wireless telegraphy will be no less important when peace comes than it has been during the war. (Hear, hear.) In speaking with a very eminent officer of the United States Navy Department a day or so ago he told me that, although before the war he was of a very different opinion, he has now come to the conclusion that no new long-distance cables will ever again be laid; that, in his view, wireless telegraphy is thoroughly efficient for all telegraphic purposes. It would not be, perhaps, altogether advisable for me to express such views, but I think you will be glad to hear those of a practical man holding such an important position in so great and progressive a country as the United States of America. (Hear, hear.)

It remains for me now only to express my sincere thanks to my colleagues, managers, and the whole staff of the company for the loyal and wholehearted support which all, without exception, are ever ready to afford me. I now move "That the report of the directors submitted, together with the annexed statement of the company's accounts to December

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31, 1917, duly audited, be received, approved and adopted." (Cheers.)

Captain H. RIALL SANKEY :—I have much pleasure in seconding the resolution.

The CHAIRMAN, having put the resolution to the meeting and declared it carried unanimously, said :—I am sorry I omitted to give you the opportunity of asking questions, but it is not too late now. If anybody would like any further information, or to put any questions on the accounts, I shall be glad to answer them.

THE DISCUSSION.

The HON. D. O'BRIEN.—Can you tell the shareholders, Sir, in comparison with the treatment this company has received from the British Government in respect to a settlement for the use of its stations in the United Kingdom, what the treatment by the American Government has been of the American company, and particularly how many months elapsed from the entry of the American Government into the war before they came to a settlement with the American company ?

The CHAIRMAN.—I think I have already answered that question, in part, in my speech. I have told you that the American Government have completed an arrangement with the American company on terms which the American company thought reasonable, and that the American Government are making their payments under the agreement monthly. I believe I am right in saying that an agreement was come to within a month or two of America joining in the war. (Hear, hear.)

The HON. D. O'BRIEN.—Thank you. That is all I wanted to know.

Mr. LANHAM.—It seems to me, with regard to these meetings, which I have attended for some years, that more or less the same things are said each time, and with regard to the delay of any settlement by the Government, of course we have all got used to that. I myself have bequeathed anything I may get out of it to my grandchildren. (Laughter.) We must not overlook the fact that at these meetings the statements from the chair are *ex parte*, which, I believe, means one-sided only. If I am wrong, the chairman will correct me, as I know he knows Latin words. (Laughter.) Now, it seems to me—although I am afraid little good will be gained by my remarks, because it is too late—that if our directors had tackled the problem on the same business lines that the American directors have done, instead of talking more or less sheer patriotism, to give it a good name, because I think that was the idea when they allowed the Government without any arrangement to make use of the company's stations—a thing which I venture to say no other business concern in this country has done, as far as my knowledge goes from reading the papers—instead of fixing up a business agreement they said, in effect, " We are willing to help you ; take what you like from our stall, there is no price on anything, we will arrange the price afterwards." (Laughter.) Well, gentlemen, that is very generous, but the directors here represent a vast deal of shareholders' money, and the lack of an arrangement at that time, although patriotic and generous, and to a certain extent highly meritorious, was not business as we understand it to-day. I think that that is the reason for the gigantic claim, the beginning of it, which we are making to-day. It is practically the cause of the whole trouble, and I certainly think it should have been avoided.

The CHAIRMAN.—Will you put your question, sir ?

Mr. LANHAM.—I am putting the other side of the case.

The CHAIRMAN.—I wish to hear your question, if you have one, as that is what I am desirous of dealing with at the moment.

Mr. LANHAM.—Yes, I know, but I am trying to put my view of the matter.

The CHAIRMAN.—I am not complaining, but I offered to answer questions.

Mr. LANHAM.—I am rather a " high-priced shareholder," and I am expecting some day to get my money back. I am not a holder of one share. One other point to which I want to refer is this : You told us that the non-receipt of this large sum of money has retarded your programme and ideas of progress in other parts of the world. If you intend to use that money when you get it for the benefit of your large projects, how do we stand ? If the shareholders present will throw their mind back a few years they will remember, I think, that you told us that when this sum, which two years ago was very near—last year it was practically being served over the counter, and this year it is practically safe—you told us that when that amount was received it would to a large extent, not the total perhaps, be distributed among the shareholders. (Hear, hear.) Now, which of those hypotheses or statements is correct ? They cannot both be. It must be one or the other, and I should like you to tell us whether your statement of two years ago, or the inference I draw from what you have said to-day, is correct.

CHAIRMAN'S REPLY TO QUESTIONS.

The CHAIRMAN.—In reply to the first part of the question I would like to tell you in a few words what took place. You will remember that on August 4, 1914, war was declared. There were innumerable things that the Marconi Company was called upon to do, and to do immediately, and its staff remained at work night and day to do those things. (Hear, hear.) I do not think there is a single shareholder in the company who would have approved of the managing director saying, " No ; tell us what you are going to pay us before we do these things so important to the country." We proceeded without question of remuneration, and did whatever was asked of us, and we did it well, and we are looking for fair treatment. I think every man in the country has a right to look for fair treatment from the Government, acting on behalf of the rest of the community. On the question of what we shall do with the moneys we receive, let me say that a bonus will be paid. I have no reason to change the statement I then made. (Hear, hear.) But the moneys which we are entitled to receive from the several different Departments, and for different purposes, are very considerable, and a very substantial sum would certainly be available for the purpose of cementing our future abroad, and it will be used for that purpose. There will also be plenty, I think, to satisfy the most avaricious shareholder. (Hear, hear.)

Mr. HAMILTON, speaking amid repeated cries of " Sit down," said.—I wish to tell you that I have a large interest in this company. I represent also hundreds of shareholders. Let me say, too, that Mr. Isaacs's criticism of the Government is unwarranted. The whole trouble with regard to your negotiations with the Government is the absolute mistrust of many of the Government Departments of your managing director. (Cries of " No, no," and " Nonsense.")

The CHAIRMAN.—I need not tell you, gentlemen, that Mr. Hamilton is speaking without authority from the Government (hear, hear), and when the Government chooses to take up that attitude it will tell you.

Mr. JOHN WEBB.—I think I am one of the oldest shareholders in this company. I still hold 300 shares, which I acquired some years ago when the company was in very low water. Some of you may

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remember that I then asked the shareholders to bear with the directors and expressed the belief that we should see this company a great success. Now, to-day, Mr. Chairman, we have to thank you and the other directors for all you have done for us. (Cheers.) I confess that, although I hold shares in other companies, there is no company in which I hold them with greater pleasure than in this one, because I believe that Marconi's Wireless Company is a great benefit to humanity. (Hear, hear.) I believe it is doing great good in the world, and saving much life. There is one thing I should like to ask you, and that is not to "pile up" the reserves too heavily, but allow us shareholders to get a little of the benefit of the company's prosperity. We want it, because some of us have bought our shares at a very much higher price than they stand at now. All the same, I am thankful to you and to the directors generally for the splendid results you put before us to-day. (Cheers.)

SENATORE MARCONI'S CABLE OF CONFIDENCE IN MR. ISAACS.

Mr. HENRY W. ALLEN.—Mr. Chairman, ladies, and gentlemen, I have just received the following telegram from Senatore Marconi:—"Most deeply regret verdict in Isaacs case. Please express my sympathy to Mr. Godfrey Isaacs and inform him and the general meeting that I heartily associate myself with the resolution of the board, and that he has now, as during the eight years of his association with me, my entire belief in his honesty and integrity. His evidence, as reported in newspapers which have reached me, is identical with his account of facts as related to me before any case was contemplated. Sincerely hope retrial may be granted." (Cheers.)

The CHAIRMAN.—I have now to move:—

"That a final dividend of 15 per cent., equal to 3s. per share, less income-tax, upon the Ordinary Shares now issued and paid up, be and the same is hereby declared for the year ended 31st December, 1917; that a final dividend of 10 per cent., equal to 2s. per share, less income-tax, upon the Cumulative Participating Preference Shares, be and the same is hereby declared for the year ended 31st December, 1917; that the said dividends be payable on the 14th August, 1918, to shareholders now registered on the books of the company, and to holders of share warrants to bearer."

Mr. ALFONSO MARCONI.—I have pleasure in seconding that.

The resolution was unanimously agreed to.

Mr. MAURICE A. BRAMSTON.—I beg to move:—"That the directors, Mr. Alfonso Marconi, Captain H. Riall Sankey, and Mr. Henry William Allen, who retire in accordance with Article 81, be re-elected directors of the company."

Mr. SAMUEL GEOGHEGAN.—I second that.

The resolution was unanimously carried.

The CHAIRMAN.—Will some shareholder now kindly move the resolution with regard to the auditors?

Mr. A. B. CROFT.—I move:—"That Messrs. Cooper Brothers and Co. be re-elected auditors for the ensuing year, and that their remuneration for auditing the accounts to the 31st December, 1917, be 600 guineas."

The HON. D. O'BRIEN.—I second that with pleasure.

The resolution was carried unanimously.

The CHAIRMAN.—I think, ladies and gentlemen, that concludes the business of the day. (Cheers.)

The proceedings then terminated.

"Sea, Land and Air"

IN the "Library Table" of our June issue we reviewed the first number of the new Australasian magazine entitled *Sea, Land and Air*, and a recent mail from the Antipodes has brought us two subsequent issues. The subject matter therein treated attains fully as high a standard as that in the maiden issue, whilst the presentation and format show a marked improvement. The two covers, particularly that of No. 2, are both striking and pleasing.

Amongst the many items of interest included in the new issues will be found one which must arrest the attention of every reader; we allude to "The Submarine Destroyer," an article specially contributed to this enterprising Journal by Ernest Osborne. Though a description of actuality, the article appears in narrative form, and is artistically framed in such a way as to arrest readers' attention from the moment that the wireless operator is instructed to rig up his wireless mast to the time when the destroyer crashes into the observation structure of the German craft and sends the great sea wolf to its doom 12,000 miles from home.

Issue No. 3 contains a remarkable series of exclusive photographs, telling the story of the excitements and adventures of Australian flying men in the Holy Land, and the six pages of illustrations convey a more vivid impression of the warfare and conditions of life in the Holy Land than could be imparted by twice the space devoted to descriptive text. The same issue contains an article devoted to an account of the work of Australian wireless signallers attached to our fighting forces. This article appears under the heading of "The Nerves of the Army" and has been specially written for *Sea, Land and Air* by Lieut. Horace J. Firth, A.I.F., a writer who has been on active service with various signal units since August, 1914, first in German New Guinea, and afterwards in Egypt, Gallipoli and France; who had the good fortune, moreover, to be at the landing at Anzac with a wireless section which was there and in action on the heels of the first attacking party.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly.* (3) *Queries should be as clear and concise as possible.* (4) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers.* (5) *The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

R. R. (Southsea).—Rightfully, the Marconi uniform should only be worn by wireless operators in the employ of the Marconi Company. The company's students may only wear this uniform when authorised by the company's representative after passing certain tests. With regard to the transport badge, only those operators who are actually on the articles of His Majesty's transports are entitled to wear it. No matter how long an operator has been in the service of the Marconi Company he is not entitled to wear a transport badge if he is not so employed. Students and others who improperly carry this badge are rendering themselves liable to very serious consequences.

M. L. (Letchworth).—(1) You are quite right, it also depends upon the number of turns of wire. (2) The product of the volts and amps is roughly equal in both primary and secondary circuits, although owing to losses in resistance, etc., the secondary output is bound to be less than the primary input. Assuming no losses as above, the amperage in the secondary would be 8 milliamperes (0·008 ampere).

F. R. P. (Gillingham).—We are making inquiries regarding your case, and will let you hear further by post.

PRIVATE P. K. L. (Birmingham).—(1) You are partially right. Aeroplanes can now receive messages in flight, and while the engine is running. They do not use the magnetic detector, however! Further particulars we must not give. (2) Yes, a few, but only in a very limited way. After the war you may expect to see enormous strides in wireless telephony. Thanks for your good wishes; they are very welcome in these times of difficulty.

P. O. (Cliveleys).—So far as we know, yes, if other circumstances were favourable. Why not apply to the authorities and find out? They can tell you whether present conditions permit of it.

E. S. B. (Guildford).—(1) The receiver of a wireless installation can be tuned to many degrees of fineness. That is to say, it can be made sensitive either to a certain definite wave-length (this is called "sharp tuning"), or to a wide range of wave-lengths. Thus, if the operator at a station wishes to listen for any signals which may be about, he adjusts his receiver so that the tuning is not sharp. Then, when he hears a station on a certain wave, he tunes his instrument to be sensitive to that wave-length only. (2) No, not all stations. Ships of the Mercantile Marine are limited for certain reasons to two wave-lengths only: 300 and 600 metres. If more than two ships wish to work at the same time, and they are liable to interfere with one another, they are allotted priority according to certain rules. Land stations use a large variety of wave-lengths, some as long as 12,000 metres. The tendency is to increase wave-lengths for long distance working. (3) This is too large a question to be answered here. Briefly, by adjusting his transmitter to the wave-length of the other ship and endeavouring to overpower or "shout him down." How near he may need to be depends on the

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powers of the two ships. A powerful installation can "jam" from a greater distance than a feebler one. (4) No. It can do both. German submarines make frequent use of wireless telegraphy in both transmitting and receiving. They sometimes wish they had not when a depth charge goes off!

RADIO (Falkirk).—Height, 5 feet (minimum). Chest measurement not defined, but must not be abnormally low.

H. H.—Articles on this subject written by authorities appeared in the issues of November, 1914, and January, February, March and April, 1915.

L. H. (Liverpool).—We cannot give the range of stations of 5 kw., 1½ kw., ½ kw., ¼ kw. and 10-inch coil installation without knowing: (1) Dimensions and shape of aerial; (2) ship or shore station; (3) if the latter, nature of surrounding country and form of earth connection, and about a dozen other factors. In reply to your second question, as you do not say for what purpose the aerial is used or the spacing between the wires in each case, it is impossible to give the information you require. Generally speaking, the longer aerial would be much superior. We cannot give any constructional details in wartime.

G. W. (Crystal Palace).—We believe a general commission is necessary.

C. H. P. (Harrogate).—One of the best books we know on the subject of small power transformers is *The Construction of Small High-Tension Transformer*, by T. E. Austin, price 4s. net. Our publishers will be pleased to obtain this for you. It is exactly what you require, and can be confidently recommended.

CALCULUS (Portsmouth).—The machine you mention is of patented construction, and has a winding quite different from that in use on most machines. Space will not permit of our describing it in detail.

N. B. X. (Glasgow).—Marconi operators do not have to wear swords, nor are they permitted to do so. Swords are only worn by certain officers in His Majesty's Army and Navy, and then not on all occasions. They are mostly ornamental in these days.

"SPARKS" (Belfast).—(1) There are normally only two grades of Postmaster-General's certificate, first class and second class. As a temporary measure, two other grades have been introduced—*i.e.*, temporary officer-in-charge and temporary assistant operator. The examination is the same in all cases, and which certificate is allotted depends upon the knowledge displayed by the candidate. The last two mentioned certificates are only issued in certain circumstances, and may no longer be issued when the present conditions alter; (2) this depends on the requirements at the time; (3) it is certainly a help; (4) the Marconi Company require an applicant to sign an agreement to serve at least one year. We are glad you like our magazine, and trust it will continue to be helpful.

C. L. B. (H.M.S. ——).—These questions are rather outside our province. We would suggest that you write to the Institution of Electrical Engineers.

SPECIAL NOTE.

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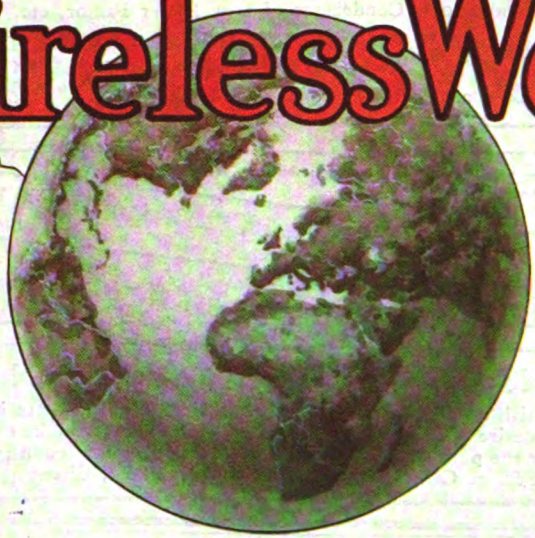

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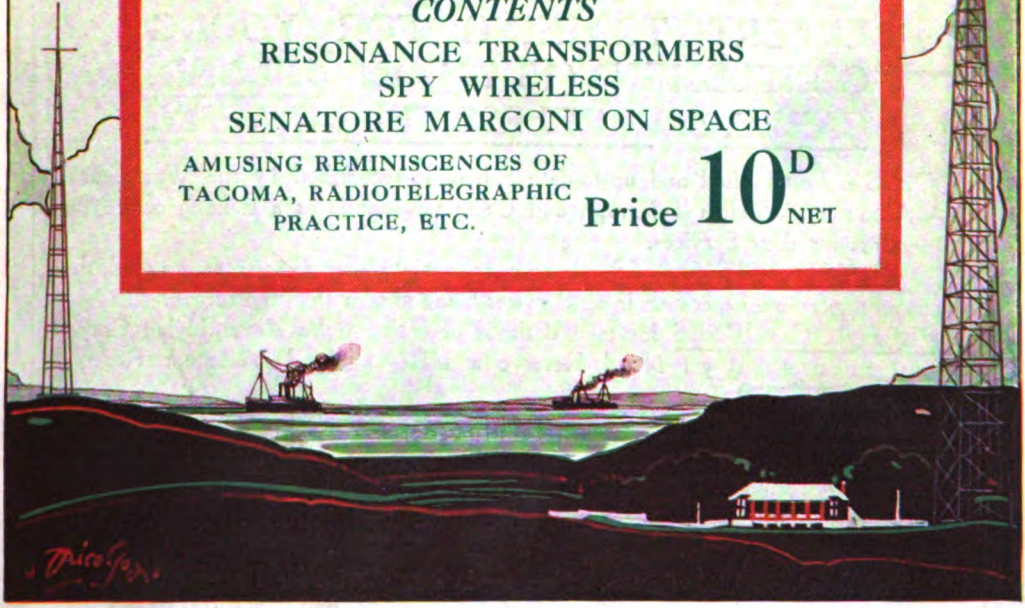

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Single copies, 10d. each, or post free 1s. 1d.

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The
WIRELESS
·WORLD·

Volume VI. No. 67. OCTOBER, 1918.

Reminiscences of an Operator

Tacoma, Washington, U.S.A.

By WILLIAM D. OWEN

ONE would have thought that our arrival in Tacoma was an event of prime importance if one had taken the local papers seriously. Judging by the publicity we got it seems that they were short of news.

Among the first to board our vessel was a small crowd of reporters, who appeared to think that the wireless operator, by virtue of his office, would be able to provide them with much "copy." Unfortunately for them I had been warned beforehand to be on my guard when dealing with these estimable fellows if I wished to avoid notoriety. So, emulating Billy Muggins in the popular song, I stuck to generalities.

One reporter, more persistent than his colleagues, remained behind after the main body had retreated. He asked me if I knew the *value* of news. I told him that I did not know much about the value of news, but that I knew a great deal about the value of silence. "Sheer bunk!" he replied; "three parts of the vain regrets of life are over wasted opportunities. Tell me what you know of the Agadir incident" (this was in 1911). "I'll work it up into a big feature for to-morrow's issue and we'll share the dough." When I told him that all I knew about the incident in question had been learned from the American papers he shut up his notebook smartly and said, "Wal, I guess the deal's off." Then changing the subject he asked if I intended to go to the Gotch wrestling match that night. In reply I put my hand into my pocket and pulled out a miscellaneous collection of coins that had accumulated

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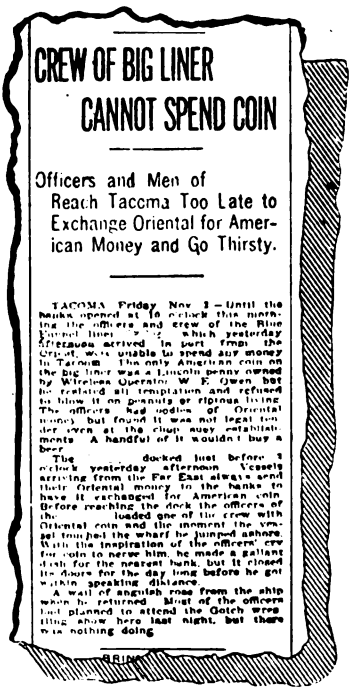

CREW OF BIG LINER
CANNOT SPEND COIN

Officers and Men of Reach Tacoma Too Late to Exchange Oriental for American Money and Go Thirsty.

TACOMA, Friday, Nov. 3.—Until the banks opened at 10 o'clock this morning the officers and crew of the Blue Funnel liner ——, which yesterday afternoon arrived in port from the Orient, were unable to spend any money in Tacoma. The only American coin on the big liner was a Lincoln penny owned by Wireless Operator W. F. Owen, but he resisted all temptation and refused to blow it on gaiety or riotous living. The officers had oodles of Oriental money, but found it was not legal tender even at the cheap saucy establishments. A handful of it wouldn't buy a beer.

The —— docked just before 1 o'clock yesterday afternoon. Vessels arriving from the Far East always send their Oriental money to the banks to have it exchanged for American coin. Before reaching the dock the officers of the —— loaded one of the crew with Oriental coin and the moment the vessel touched the wharf he jumped ashore. With the inspiration of the officers' cry for coin to nerve him, he made a gallant dash for the nearest bank, but it closed its doors for the day long before he got within speaking distance.

A wail of anguish rose from the ship when he returned. Most of the officers had planned to attend the Gotch wrestling show here last night, but there was nothing doing.

in the course of a twenty-thousand mile voyage. "I don't suppose any of this is legal tender over here," I said; "the only American money on the ship is this Lincoln cent and that's a keepsake." He raked about among the coins for a moment, smiling to himself the while, and then he left. Next morning I woke to find myself a local celebrity, as famous as though I'd been snatched from death by a timely dose of Seagull's Syrup or had mended a broken leg with Dr. Jess's Lying Ointment. The newspaper cutting* reproduced explains my sudden ascension to fame.

I was not enamoured of Tacoma at first. It struck me as being a dull sort of place, but I soon changed my opinion after having seen its Fire Brigade. I happened one day to be strolling along Pacific Avenue when suddenly a large electric bell upon one of the light standards began to ring excitedly. The effect of that bell upon the populace was rather curious; all who happened to be on the scene rushed to the sidewalk and lined the streets, craning their necks eagerly in a certain direction. Now a fire in Tacoma is a serious matter, because the older buildings are made largely of wood and the more modern ones are very tall. So they have to be smart in their counter measures. And they are. Within twenty seconds of the first stroke of that bell—which apparently was to warn the users of the streets that the roadway was unhealthy—a huge nightmare fire-engine swung round the corner on two wheels and flew up the road at a speed something like forty miles an hour. It carried a complement of grotesquely attired firemen and a nerve-shattering bell which had the phantom characteristic of being invisible. Following close behind it was another and a third, each successive one more speedy than the former. I had just begun to breathe again when a little red car consisting of three parts engine and the other part noise tore past at a speed I had never seen equalled on the road. It went up a one-in-six hill as though no hill existed. That car contained the Superintendent and his chauffeur. My neighbour, recognising that I was a stranger, volunteered the information that its speed was seventy miles an hour, and I did not doubt him.

Next moment a weird sound assailed us, like the moaning of a lost soul. It was the signal for a fresh outburst of excitability on the part of those around me. "Here comes the doggoned six-wheeler!" yelled my neighbour into my starboard ear. The crowd moved bodily toward another corner; I did likewise—I had no option in the matter—and I saw the centre of disturbance. It appeared to be a bright light and a cloud of smoke moving rapidly towards us, and in a few seconds it evolved into the most fantastic fire fighting machine I had ever seen or imagined: a six-wheeled motor fire-escape of 100 horse-power, so long that steering gear was fitted to the back wheels as well as the front. In less than three minutes there were no less than ten mechanical abortions belching forth petrol, gas, hell-fire and Brock's benefit. They encircled a cinematograph theatre, where apparently a film had ignited, thus giving rise to the alarm. That it was extinguished without so much as a spark being seen by the eager crowd outside may be regarded as an indication of the efficiency of the Tacoma Fire Brigade. But those machines fascinated me. I walked round one monster, paying it silent homage with every fibre of my being. I even touched it. I peeped under the open sides of the engine-bonnet and watched the camshaft

* The name of the liner has been deleted by the Censor.

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playing an andantino upon the valve-stems. I looked at the superman who handled the thing. I wanted to shake hands with him, but he was too busy picking his teeth. It seemed strange to me that a man who had tamed this throbbing monster should have trouble with his teeth just like ordinary people. I was bewildered; I wanted to be alone with my thoughts. My sleep that night was disturbed by visions of fire-engines, as long as trains, chasing little red cars up and down interminable staircases.

Next day I took fifteen grains of potassium bromide and went to the "movies" with the second engineer. The pictures were so dry it was only natural that we should look around afterwards for an antidote, and we found the Café Bohème.

A gentleman of doubtful ancestry took our hats and coats and asked what we desired. I wanted one of those long chromatic drinks with straws stuck into it, but when I gave my order the gentleman of doubtful ancestry handed me back my hat and coat, saying with superb dignity, "This, sir, is a cabaret, not a Y.M.C.A." I begged his pardon and said I'd take anything wet, leaving the choice of label to his discretion. I was fortunate in my reply, for he took his calling very seriously, and, after a moment's deliberation—during which he held his chin in his left hand and said, "Let me see; let me see, now"—he strutted off with the air of a man whose mind is made up. I now felt at liberty to look around—a proceeding quite out of the question in his presence. We were in a huge square hall, below the level of the street. The marble steps from the vestibule to the main floor might have graced a cathedral and the floor itself was a masterpiece of mosaic. Dozens of tables, richly set, arranged themselves into a great horseshoe around a miniature stage and an orchestra sat entrenched behind a grand piano. Each table had its complement of vivacious humanity, disciples of Omar Khayyám intent on the worship of Bacchus.

"We're in for it now, Marconi," said the second. "Guess that's so," I replied in my best American. Further discourse was prevented by the return of our gentleman with a tray bearing two bottles of Pilsener, two conical glasses and a box of cigars. Well do I remember those cigars—Mexican Planters they were, and I have since sought for them in vain from Singapore to Edinburgh, from Vancouver to Kowloon. He relieved us of a sum so trifling that I felt half ashamed to offer it, kept the change with the *sang froid* of a perfect waiter, and then became enveloped by the throng.

I sat me down to philosophise, watching the bubbles in the glass with that pleasurable anticipation that children of all ages delight to inflict upon themselves, and my thoughts were rudely disturbed by the opening chords of some musical contortions

THE PERSISTENT REPORTER IN SEARCH OF "COPY."

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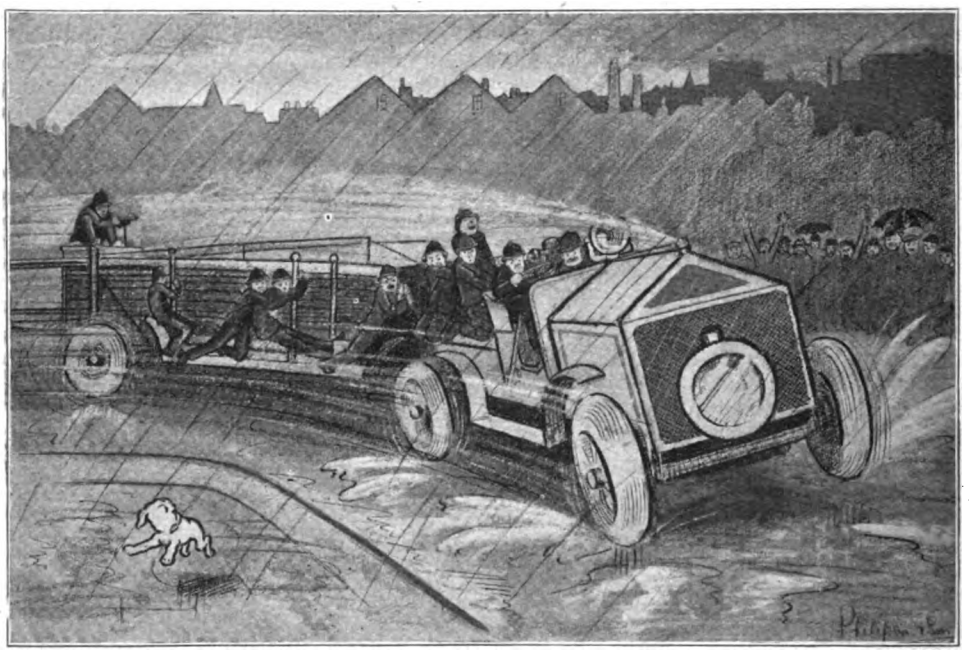
played on the piano by a German Jew whose long hair had St. Vitus's dance and who seemed to be in great physical pain, judging by the writhings of his body. I had never before seen a full-grown man playing hop-scotch on a grand piano when by all the signs and portents he should have been in the hospital under treatment for ague. He played with vigour, swayed with and pedalled with vigour. Vigour marked every movement and quivered from every limb. Fortissimo was his motto and energy his stock-in-trade. With so great an expenditure of muscular tissue it was only natural that his contribution to our entertainment should have been short. He fell exhausted into a chair at a near-by table and I saw the gentleman of doubtful ancestry pass him a glass of something—evidently medicine. He rallied a little, but during convalescence his place was taken by an æsthetic-looking consumptive whose overgrown locks had evidently absorbed all the vitality of his system.



"HERE COMES THE DOGGONED SIX-WHEELER!"

He seemed to be a musician of quite a different school. He dallied with the piano, poising his hands above the notes as though reluctant to play them. He, too, possessed animated hair and St. Vitus's dance, but I didn't have much time to devote to him, for his music had drawn from some secluded nook a feminine atrocity in a cerise muslin sheath on "hobble-skirt" lines. "Mutton 'dressed' as lamb," whispered my companion.

It must have been a competition of some sort, for she sang against the pianist, and the first bout was a draw. On the second round she had the advantage, but at the end of the third round the pianist was quite five bars behind, but nobody seemed to mind, for was not the beer good and were not the ladies charming?

After a brief spell of the familiar discord with which a string band always preludes its performance, and which the Shah of Persia considered the cream of Western music, we were treated to some musical selections. There was no programme, but anyone with a little imagination and a musical soul could put one together for himself.

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Having both it was not difficult for me to make out the titles. From what I remember of them they were as follows :—

DESCRIPTIVE : " Revolution Français "	*Sousa*
SELECTION : " Derby Day "	*Tschaikowski*
REVERIE : " Phantasmagoria "	*Keulah*
DESCRIPTIVE : " Mile End Road on a Saturday Night " ...	*Wagner*

Now there were about eight of those musicians and every one of them stark, staring mad. They played *on* their instruments and they played *with* their instruments. They made grimaces at their instruments one moment and fondled and caressed them the next. The instruments themselves seemed to enter into the spirit of the thing, for never in my life have I heard such a carnival of din. They would start with a slow, mournful movement, melancholy yet harmonious, and they would wander off, each on his own, as it were, quickening the time and swelling out to a climax of discordant fury. Then they would amble back, one by one dropping into the main theme, and would come to an abrupt finale with a triumphant chord. My ! they were the greatest musicians that ever disturbed the air within the range of Tympanum. That experience cost me just twenty-five cents, about a shilling, for which sum I had a cigar fit for the gods, two glasses of beer, selections by the bewitched orchestra, and I'd seen Life. After which I returned to my virtuous couch, marvelling greatly.

SELECTIONS BY THE BEWITCHED ORCHESTRA.

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PERSONALITIES IN THE WIRELESS WORLD

MONS. ANDRÉ EUGÈNE BLONDEL

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EARLY in 1863, André Eugène Blondel was born at Chaumont on the Marne. After being educated at the Lycée of Dijon, Mr. Blondel graduated at the Polytechnic School of Paris (1883), at the Universities of Paris (1885) and Dijon (1889), and at the National School for Bridges and Ways, where he obtained the first rank (1888) and the title of State Engineer of Bridges and Ways.

Having been appointed Engineer, and afterwards Engineer-in-Chief, to the Central Service of Lighthouses, Mr. Blondel turned his attention and energies towards the scientific subjects with which this service was concerned, such as Optics and Photometry, the Electric Arc, Electrical Machinery, Radiotelegraphy, Aerial and Submarine Signals. Selected in 1893 as the first occupant of the new Chair of Applied Electricity of the National School for Bridges and Ways, he made a large number of contributions to the publications of learned Societies, in addition to which he published in technical journals, etc., numerous monographs covering a wide range of subjects.

Besides his work on the Blondel Oscillograph and the theory of alternators, he paid particular attention to Radiotelegraphy, and published numerous articles on the research work carried out by him in connection with oscillating arcs, resonance transformers, directional radiotelegraphy and many other problems.

Mr. Blondel's achievements have been recognised by the French Government, who appointed him President of the Technical Commission of Military Applications of Electricity (1914). In 1913 he had been elected President of Comité Française de T.S.F. Scientifique, and a member of the Comité Technique des Postes et Télégraphes, in whose hands is vested the supreme direction of State radiotelegraphy in the Republic.

He was elected an Honorary Member of the American Institute of Electrical Engineers in 1912 for having " rendered service of the "highest value in the advancement of the electrical science and " arts, and notably by his work with relation to alternating-current " wave-recorders, the composite-electrode arc lamp, the distribution " and measurement of light and illumination, the theory and design " of alternating-current apparatus and the theory and calculation " of transmission and distributing systems." He is a member of the Académie des Sciences of Paris, and an Honorary President of the Société Française des Electriciens, Vice-President and Honorary Member of the Illuminating Engineering Society, etc. He was elected also, in 1917, a Fellow of the American Institute of Radio Engineers.

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The Power Factor in the Resonance Transformer Circuit

By P. BAILLIE, L.Sc.

It may seem somewhat paradoxical to speak of power factor when dealing with a circuit whose electrical constants are so chosen that the circuit is tuned to the frequency of the alternator. However, considering the case of the feeding circuit of any modern transmitting plant will show that though the current is in step with the voltage, the power is not equal to the product of the R.M.S. current and voltage, as read off the ammeter and voltmeter. The effective power is always smaller than this product. We may therefore define an angle φ by the equation :

$$\cos\varphi = \frac{\text{Power (watts)}}{I_{\text{R.M.S.}}\,(\text{amperes}) \cdot V_{\text{R.M.S.}}\,(\text{volts})}$$

The factor $\cos\varphi$ is the power factor.

The angle φ is not a phase difference between the amperes and volts.

It is known—WIRELESS WORLD, August 1917—that the instantaneous current i and voltage v across the transformer primary—the circuit being tuned to the alternator frequency—are :

$$i = -\frac{E_\circ}{R}\,(1 - e^{-\alpha t}) \cdot \sin \Omega t$$

$$v = E_\circ \cdot S\,(1 - e^{-\alpha t}) \cdot \cos \Omega t$$

with the following notations :

$E_\circ$ = maximum E.M.F. of the alternator.

R = total ohmic resistance of the circuit, including the resistance equivalent to magnetising current and resistance of secondary winding.

S = surtension $= \dfrac{L\,\Omega}{R}$

K = number of semi periods between two consecutive sparks $= \dfrac{\Omega}{\pi N}$

N = number of sparks per second.

α = damping factor $= \dfrac{R}{2L} = \dfrac{\Omega}{2S}$

The flow of electricity through the circuit is a succession of transient states of $\frac{1}{N}$ second duration. A spark occurs long before any sine current—or voltage—of constant amplitude has had time to establish. In other words, the exponential factors which take place in the expres-

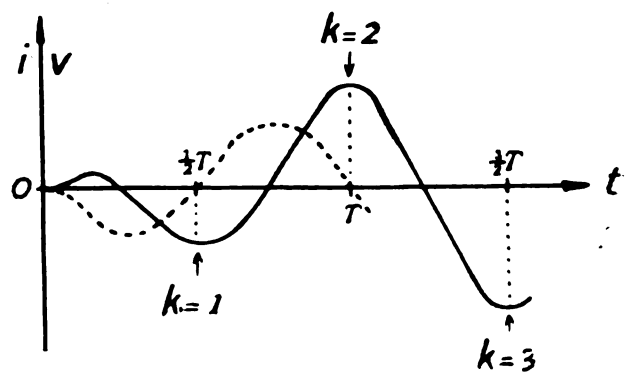

FIG. 1.

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sions of i and v have too large values, when the spark occurs, to be neglected and to permit of considering the current as a sine function of time. This is obvious from Fig. 1. The exponential factor increases with the surtension S and number of sparks N. Therefore, the larger S and the smaller K, the smaller the power factor.

The value of the power factor may be deduced from the power, and the R.M.S. current and voltage.

The power generated by the alternator is—WIRELESS WORLD, June 1918:

$$P_a = \frac{N \cdot E_0^2}{R}\left[\frac{K\pi}{2\Omega} - \frac{S}{\Omega}\left(1 - e^{-\frac{K\pi}{2S}}\right)\right]$$

and power at the spark gap:

$$P_{o.c.} = \frac{1}{2} N c a^2 E_0^2 S^2 \left(1 - e^{-\frac{K\pi}{2S}}\right)^2$$

The efficiency ρ is therefore:

$$\rho = \frac{P_{o.c.}}{P_a} = \frac{S\left(1 - e^{-\frac{K\pi}{2S}}\right)^2}{K\pi - 2S\left(1 - e^{-\frac{K\pi}{2S}}\right)}$$

Values of ρ have been given in the quoted article.

A power $(1-\rho) \cdot P_a$ is expanded into heat and the R.M.S. current is:

$$\underset{\text{R.M.S.}}{I}\ (\text{amperes}) = \frac{(1-\rho) \cdot P_a}{R}$$

hence:

$$\frac{\underset{\text{R.M.S.}}{I}\ (\text{amperes})}{\frac{E_0}{\sqrt{2}} \cdot \frac{1}{R}} = \sqrt{(1-\rho) \cdot \left[1 - \frac{2S}{K\pi}\left(1 - e^{-\frac{K\pi}{2S}}\right)\right]}$$

It may be noted that $\frac{E_0}{\sqrt{2}} \cdot \frac{1}{R}$ is the R.M.S. current when the key is depressed and the sparking distance so large that no spark can jump across.

The R.M.S. voltage cannot be calculated in the same way. We have:

$$V^2_{\text{R.M.S.}} = \frac{\Omega}{K\pi}\int_{t=o}^{t=\frac{K\pi}{\Omega}} v^2 \cdot dt = \frac{\Omega}{K\pi} \cdot \frac{E_0^2 S^2}{2}\int (1 + e^{-2\alpha t} - 2e^{-\alpha t}) \cdot (1 + \cos 2\Omega t) \cdot dt$$

The general integral is:

$$t + \frac{\sin 2\Omega t}{2\Omega} - \frac{e^{-2\alpha t}}{2\alpha} + e^{-2\alpha t}\,\frac{2\Omega \sin 2\Omega t - 2\alpha \cos 2\Omega t}{4(\alpha^2 + \Omega^2)} + \frac{2e^{-\alpha t}}{\alpha}$$

$$- 2e^{-\alpha t}\,\frac{2\Omega \sin 2\Omega t - \alpha \cos 2\Omega t}{\alpha^2 + 4\Omega^2}$$

The same assumptions that were made to calculate the power may be made here. Therefore we have to neglect $\frac{1}{4S^2}$ and *a fortiori* $\frac{1}{16S^2}$ before unity. In other words, α^2 and $4\alpha^2$ may be neglected compared with $4\Omega^2$. Putting:

$$tg\, p = \frac{\alpha}{\Omega} = \frac{1}{2S} \qquad tg\, q = \frac{\alpha}{2\Omega} = \frac{1}{4S}$$

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the general integral is :

$$t+\frac{\sin 2\Omega t}{2\Omega}+e^{-2\alpha t}\left[\frac{\sin(2\Omega t-p)}{2\Omega}-\frac{1}{2\alpha}\right]$$
$$+e^{-\alpha t}\left[\frac{2}{\alpha}-\frac{2\sin(2\Omega t-q)}{\Omega}\right]$$

and the definite integral :

$$\frac{K\pi}{\Omega}+\left(\frac{1}{2\alpha}+\frac{\sin p}{2\Omega}\right)\cdot\left(1-e^{-\frac{2\alpha K\pi}{\Omega}}\right)-\left(\frac{2}{\alpha}+\frac{2\sin q}{\Omega}\right)\cdot\left(1-e^{-\frac{\alpha K\pi}{\Omega}}\right)$$

Accounting for the following equations :

$$\frac{\alpha k\pi}{\Omega}=\frac{K\pi}{2S};\ \sin p=\frac{\frac{1}{2S}}{\sqrt{1+\frac{1}{4S^2}}}\ \#\ \frac{1}{2S}$$

$$\sin q=\frac{\frac{1}{4S}}{\sqrt{1+\frac{1}{16S^2}}}\ \#\ \frac{1}{4S}$$

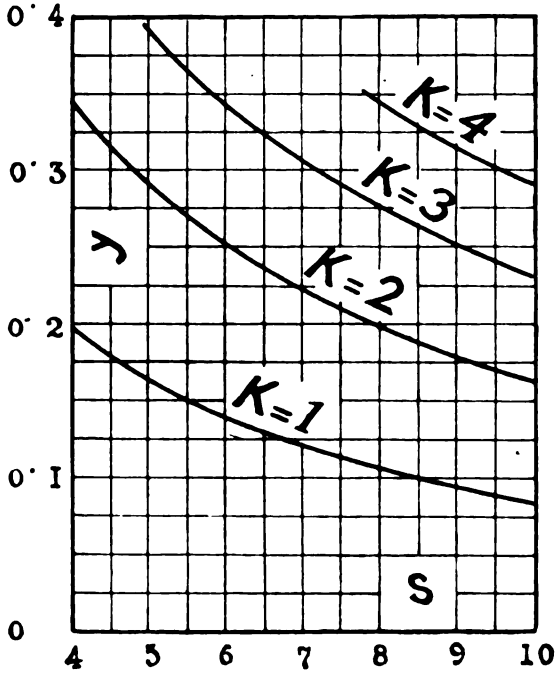

FIG. 2.

and multiplying by $\frac{\Omega}{K\pi}\cdot\frac{E^2S^2}{2}$ we obtain the square of the R.M.S. voltage

Hence :

$$\frac{V_{R.M.S}}{\frac{E}{\sqrt{2}}}S=\sqrt{1+\frac{S}{K\pi}\left(1-e^{-\frac{K\pi}{S}}\right)-2\cdot\frac{2S}{K\pi}\left(1-e^{-\frac{K\pi}{2S}}\right)}$$

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From this we deduce the power factor :

$$\cos\varphi = \frac{\left(1-e^{-\frac{K\pi}{2S}}\right)^2}{\sqrt{\left[(1-\rho)\cdot 1-\frac{2S}{K\pi}\left(1-e^{-\frac{K\pi}{2S}}\right)\right]\cdot\left[1+\frac{S}{K\pi}\left(1-e^{-\frac{K\pi}{S}}\right)-2\cdot\frac{2S}{K\pi}\left(1-e^{-\frac{K\pi}{2S}}\right)\right]}}$$

Numerical calculations show that for not too small values of $(S-S>5)$ and not too large values of $(K-K<3)$, that is, more than one spark every three semi-periods—the ratios

$$\frac{I_{R.M.S.}}{\frac{E_0}{\sqrt{2}}\frac{1}{R}} \quad \text{and} \quad \frac{V_{R.M.S.}}{\frac{E_0}{\sqrt{2}}S}$$

have practically the same value—error < 1 per cent.

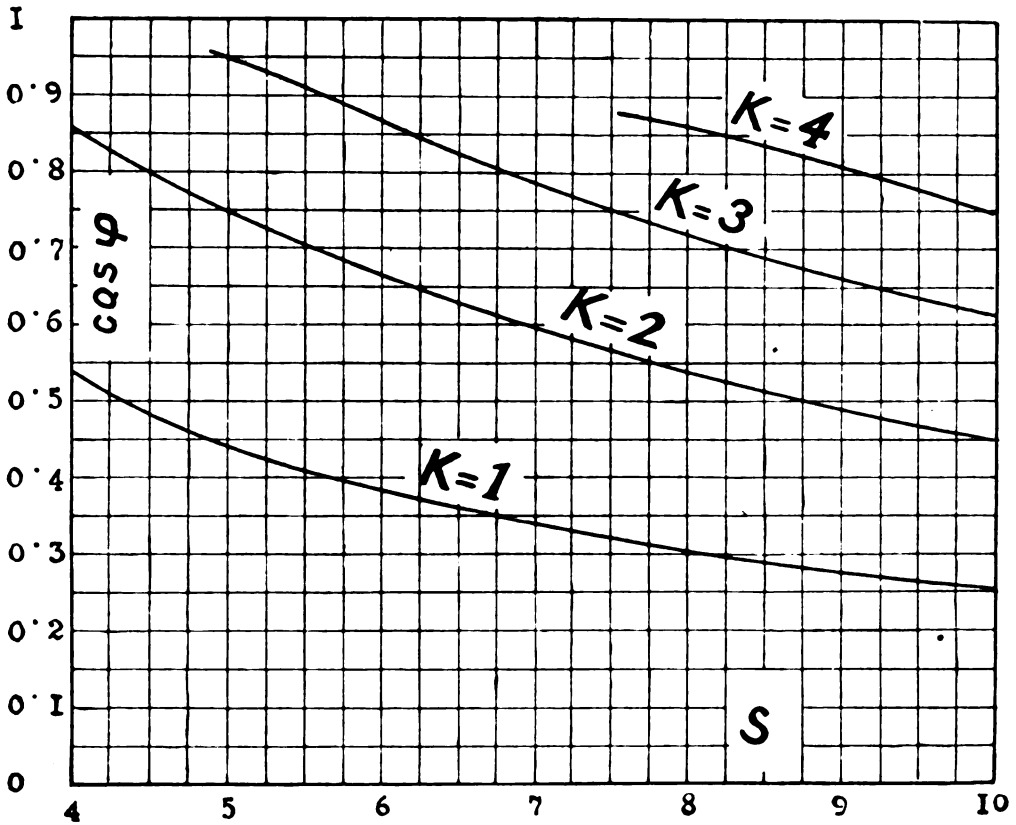

FIG. 3.

With these results, curves Figs. 2 and 3 have been plotted.

As expected, the power factor approaches unity for S small and K large.

The calculations are valid so long as $\frac{1}{4S^2}$ may be neglected. Therefore the power factor has not been calculated for values of S less than 4.

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Table I. gives the common value y of these ratios in terms of K and S, and the power factor (number in heavy type).

TABLE I.—(POWER FACTOR IN HEAVY TYPE).

K	Surtensions S:						
	4.	5.	6.	7.	8.	9.	10.
1	0·196 **0·540**	0·162 **0·443**	0·138 **0·383**	0·120 **0·336**	0·105 **0·301**	0·093 **0·275**	0·083 **0·253**
2	0·345 **0·857**	0·291 **0·745**	0·251 **0·661**	0·221 **0·592**	0·197 **0·538**	0·178 **0·487**	0·162 **0·450**
3		0·392 **0·949**	0·342 **0·865**	0·307 **0·781**	0·276 **0·717**	0·251 **0·661**	0·230 **0·613**
4					0·344 **0·860**	0·314 **0·805**	0·290 **0·748**

A source of error is to be found in the fact that however perfectly constructed the transformer is, magnetic leakage is unavoidable. Therefore, the assumption that all the inductance of the circuit is external to the transformer is not quite correct. A small part—of the order 2 to 4 per cent.—of this inductance, equivalent to leakage, is located between the points where the voltmeter is connected. The measured effective voltage is therefore a little smaller than the calculated value.

Nevertheless, this is a means of quickly estimating, within a few per cent., the power supplied to the condenser of a transmitting plant, when no wattmeter is available.

It may be pointed out that the surtension S is equal to the R.M.S. voltage across transformer primary, when the key is depressed and the discharger disconnected, divided by the R.M.S. electromotive force of the alternator.

Wireless Time Signals

Establishment of New Radiating Station at Balboa (Panama)

MASTERS and seamen of vessels voyaging in the vicinity of the Pacific Coast and Panama Canal will be interested in the particulars of a new wireless station erected at Balboa, situated at the entrance to the Canal. The details are conveyed in an Admiralty Notice to Mariners (No. 962 of 1918), dated August 12th, 1918. The new station is situated in latitude 8° 56½″ N., longitude 79° 33¼″ W.

Wireless time-signals are sent out as follows:—A *dot* at every second from 0h. 55m. 00s. and 16h. 55m. 00s. to 0h. 59m. 49s. and 16h. 59m. 49s. Standard time, except at the 29th second of each minute, and from the 55th to the 59th second of each minute. A *dash* at 1h. 00m. 00s. and 17h. 00m. 00s. Standard time corresponding to 6h. 00m. 00s. and 22h. 00m. 00s. G.M.T., the beginning of the dash being the time-signal.

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Digest of Wireless Literature

Standards for Radio Communication.

The following Sections 1,000 to 1,028 have been abstracted from the report of the Standardization Committee of the Institute of Radio Engineers.

1,000, *Acoustic Resonance Device.*—One which utilises in its operation resonance to the audio frequency of the received signals.

1,001, *Antenna.*—A system of conductors designed for radiating or absorbing the energy of electromagnetic waves.

1,002, *Atmospheric Absorption.*—That portion of the total loss of radiated energy due to atmospheric conductivity.

1,003, *Audio Frequencies.*—The frequencies corresponding to the normally audible vibrations. These are assumed to lie below 10,000 cycles per second.

1,004, *Capacitative Coupler.*—An apparatus which by electric fields joins portions of two radio-frequency circuits, and which is used to transfer electrical energy between these circuits through the action of electric forces.

1,005, *Coefficient of Coupling* (*Inductive*).—The ratio of the effective mutual inductance of two circuits to the square root of the product of the effective self-inductances of each of these circuits.

1,006, *Direct Coupler.*—A coupler which magnetically joins two circuits having a common conductive portion.

1,007, *Counterpoise.*—A system of electrical conductors forming one portion of a radiating oscillator, the other portion of which is the antenna. In land stations a counterpoise forms a capacitative connection to ground.

1,008, *A Damped Alternating Current* is an alternating current whose amplitude progressively diminishes.

1,009, *The Damping Factor* of an exponentially damped alternating current is the product of the logarithmic decrement and the frequency.

Let I_o = initial amplitude.
I_t = amplitude at the time t.
e = base of Napierian logarithms.
a = damping factor.

Then $I_t = I_o\, e^{-at}$.

1,010, *Detector.*—That portion of the receiving apparatus which, connected to a circuit carrying currents of radio frequency and in conjunction with a self-contained or separate indicator, translates the radio frequency energy into a form suitable for operation of the indicator. This translation may be effected either by the conversion of the radio frequency energy or by means of the control of local energy by the energy received.

1,011, *Electromagnetic Wave.*—A periodic electromagnetic disturbance progressing through space.

1,012, *Forced Alternating Current.*—A current the frequency and damping of which are equal to the frequency and damping of the exciting electromotive force.

1,013, *Free Alternating Current.*—The current following any electromagnetic disturbance in a circuit having capacity inductance, and *less* than the critical resistance.

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1,014, *Critical Resistance of a Circuit.*—That resistance which determines the limiting condition at which the oscillatory discharge of a circuit passes into an aperiodic discharge.

1,015, *Group Frequency.*—The number per second of periodic changes in amplitude or frequency of an alternating current.

NOTE 1.—Where there is more than one periodically recurrent change of amplitude or frequency there is more than one group frequency present.

NOTE 2.—The term "group frequency" replaces the term "spark frequency."

1,016, *Inductive Coupler.*—An apparatus which by magnetic forces joins portions of two radio frequency circuits, and is used to transfer electrical energy between these circuits through the action of these magnetic forces.

1,017, *Linear Decrement of a Linearly Damped Alternating Current* is the difference of successive current amplitudes in the same direction, divided by the larger of these amplitudes.

Let : I_n and I_n+I be successive current amplitudes in the same direction, of a linearly damped alternating current.

Then : The linear decrement, $b=\frac{I_n=I_n+I}{I_n}$

Also $I_t=I_0\ (I-bft)$.

Where I_0=initial current amplitude.

I_t=current amplitude at time t.

f=frequency of alternating current.

1,018, *Logarithmic Decrement* of an exponentially damped alternating current is the logarithm of the ratio of successive current amplitudes in the same direction.

NOTE.—Logarithmic decrements are standard for a complete period or cycle.

Let : I_n and I_n+I be successive current amplitudes in the same direction.

d=logarithmic decrement.

Then : $D=\log.\ \frac{I_n}{I_n+I}$

1,019, *Radio Frequencies.*—The frequencies higher than those corresponding to the normally audible vibrations, which are generally taken as 10,000 cycles per second. See also Audio Frequencies.

NOTE.—It is not implied that radiation cannot be secured at lower frequencies, and the distinction from audio frequencies is merely one of definition based on convenience.

1,020, *Resonance* of a circuit to a given exciting alternating e.m.f. is that condition due to variation of the inductance or capacity in which the resulting effective current (or voltage) in that circuit is a maximum.

1,024, *A Standard Resonance Curve* is a curve the ordinates of which are the ratios of the square of the current at any frequency to the square of the resonant current, and the abscissas are the ratios of the corresponding wave-length to the resonant wave-length ; the abscissas and ordinates having the same scale.

1,026, *Sustained Radiation* consists of waves radiated from a conductor in which an alternating current flows.

1,027, *Tuning.*—The process of securing the maximum indication by adjusting the time period of a driven element (see Resonance).

1,028, *A Wave Meter* is a radio frequency measuring instrument, calibrated to read wave-lengths.

1,030, *Decremeter.*—An instrument for measuring the logarithmic decrement of a circuit or of a train of electromagnetic waves.

1,031, *Attenuation, Radio.*—The decrease with distance from the radiating source of the amplitude of the electric and magnetic forces accompanying (and constituting) an electromagnetic wave.

1,032, *Attenuation, Coefficient of (Radio).*—The coefficient which, when multi-

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plied by the distance of transmission through a uniform medium, gives the natural logarithm of the ratio of the amplitude of the electric or magnetic forces at that distance to the initial value of the corresponding quantities.

1,033, *Coupler.*—An apparatus which is used to transfer radio-frequency energy from one circuit to another by associating portions of these circuits.

The Design and Use of the Wavemeter.

The writer, in a recent issue of the *Electrical Experimenter*, mentions an interesting fact concerning a new type wavemeter (No. 28) recently brought out by the American Marconi Company. He states that there is a correcting wavemeter consisting of fixed inductance and capacities which may be excited by means of a buzzer and picked up on the main wavemeter. By this means it can be seen if the calibration has changed, and if so it can be corrected by adding or subtracting capacity on a correcting condenser, which is permanently connected around the main condenser. It is, of course, understood that the main wavemeter was calibrated with this correcting condenser half in, thus allowing an addition or subtraction of capacity to correct the calibration. The correcting condenser had a capacity of one-tenth of that of the main condenser.

Analysis of Alternating Current Wave Forms.

An interesting article appears in the *Electrical Experimenter* from the pen of Prof. F. E. Austin concerning the analysis of irregular wave-shaped alternating curves, leading up to a discussion on harmonics, which is an important problem in wireless telegraphy. The writer instances Fourier's discovery that any periodic or regularly recurring wave of any shape whatever can be shown to be made up of a number of sine waves, one of which has the same frequency as the original or resultant curve. In order to make this point clear it is suggested that a number of sine curves having different frequencies shall be drawn and added together algebraically, the resultant curve being obtained by joining up points resulting from this operation.

In order to add two or more sine curves together algebraically it is necessary to add positive values together and subtract any negative values which may occur at the points selected. If the result is positive the value thus obtained must be plotted above the line. If, on the other hand, the value is negative it must be plotted below the line.

Discussing the causes of irregularly shaped waves, it is pointed out that these may be due to irregularities in speed or non-uniform magnetic fields. These conditions may also be brought about by the nature of the load.

Some excellent guides are given for the purpose of aiding the investigator in making an analysis of an irregularly shaped wave, and it is shown that if the waves are symmetrical both above and below the line the frequencies of the component waves must be an odd multiple of the resultant. But if the curve is non-symmetrical the frequencies of the component waves are even multiples of the original. These component waves of frequencies higher than the fundamental are harmonics, and the case is considered where the notes of two wireless stations are similar in pitch but distinguishable by means of "quality." This phenomenon is brought about by the fact that although the wave representing the note is the same in each case as regards frequency, yet the arrangement of the component waves may be entirely different. The analogy is supplied by the sounding of a given note on the piano and violin. In each case the sound waves have the same frequency, but the component waves which form the resultant wave—*i.e.*, the harmonics—may have an entirely different arrangement.

Sine waves met with in wireless telegraphy are symmetrical, and it is evident that their harmonics must be odd multiples of the fundamental frequency.

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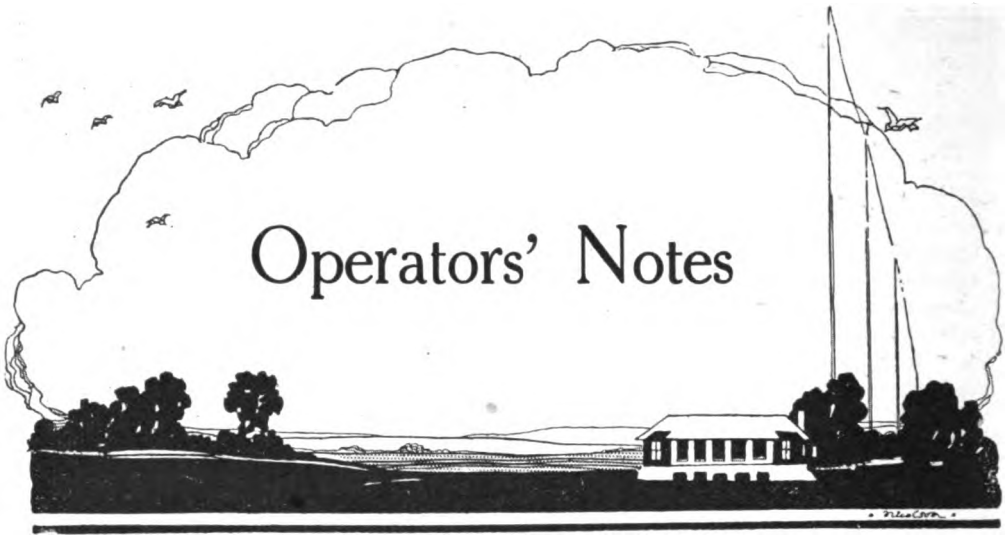

The Operator at Sea (III.)

By F. B. RUSHWORTH

As regards telegraphy pure and simple, the art of the telegraphist may be divided under three chief headings: Reception, transmission and common sense.

When the ability of a telegraphist is to be decided upon, his skill is noted in, firstly, reception—the ability to record in clear and distinct writing the signals received by the ear and transmitted to the brain; secondly, transmission—to send well-formed characters and properly spaced words; thirdly, common sense and intelligence in the transcription of messages, particularly when such are in plain language, the elimination of obvious errors, by query, and the request for repetition of doubtful words and figures.

The writer is well aware of the conditions at present obtaining in connection with radiotelegraphy at sea, and that, for obvious reasons, the key is never used in these days of war, save by the express order of the Commander. But we shall not have war with us always, and when normal conditions are restored in peace time it is hoped that these notes may prove of some value to the "new man."

Messages in which errors occur are worse than no messages at all. They are a source of irritation, annoyance, and, maybe, loss of money to the sender or addressee, or both, and undoubtedly tend to throw discredit on the service. There is really no reason why an error should ever be passed. An old and true saying is, that *anyone* can learn the code, and be able to "send" Morse characters, but a *telegraphist* is required to interpret badly formed characters and write them down correctly.

A fact not to be lost sight of is that the only useful work done in actual operating is the sending and receiving of traffic correctly, with the minimum of queries and repetitions. All else is wasted energy. In all cases when doubtful words or figures have been queried and repeated, it is the custom to mark such by placing "x" immediately underneath such words to denote that the receiving telegraphist has had the word or figure repeated and confirmed as written. A good plan also is to record the nature of any query made on the telegraph form, turning up the left lower corner for this purpose. By so doing, in the event of subsequent inquiry arising, the form will itself bear evidence of such having been made. In the case of a message

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in duplicate or for delivery, the notation would, of course, appear only on the top or office copy.

The speed of the sending telegraphist must of necessity be controlled by the capacity of the receiving telegraphist. It is worse than useless to rush a message through in fast bad sending, and have to repeat it several times before an acknowledgment can be obtained for it. A steady rate of sending, with good formation and spacing, will save much time, temper and stationery. The most expert telegraphists have at one time been learners and have gradually excelled through practice.

The junior making his first trip will find a great difference between receiving the buzzer signals he has been accustomed to at school and those heard when first listening to actual ship signals at sea. Doubtless, when putting on the 'phones for the first time on board ship he will be somewhat bewildered, and perhaps a little nervous, at the jumble of signals caused by several stations working at one time. After a little manipulation of both aerial tuning condenser and the inductance he will be able to identify particular calls, gradually losing his nervousness, which will be replaced by a sense of certainty in the reception of signals. He will, so to speak, become *quickened* to the signals, and each watch will find him more receptive.

Always write down what is *actually received.* It is most important that everything received should be copied directly on to the proper form, or recorded in the *procès-verbal* or logbook, as the case may demand.

The latter should be most accurately and carefully kept, as its production may at any time be necessary, not only to verify or confirm the entries made in the wireless logs of other ships, but as evidence in a court of law. When the watch is turned over, the exact time, and the signatures of both operators, must be recorded.

A noticeable common fault of the " first tripper " is failure sufficiently to vary the aerial tuning condenser and aerial tuning inductance. When listening-in it is of vital importance that the condenser should be frequently kept on the move, and that the coupling should not be too loose.

The slightest touch of a condenser will sometimes bring in a sharply tuned station, which may possibly have an important warning to broadcast.

Reading on watch, in these times, is to be deprecated. It is impossible to concentrate one's attention on an absorbing book or magazine and at the same time to be properly on the alert for incoming signals.

The learner is, as a rule, more backward in the art of reception than that of sending. Whilst individual painstaking practice can alone make perfect on the key, very valuable aids to reception have been rendered possible by the invention of the gramophone. Records of telegraphic signals and messages are obtainable, faithfully reproducing almost all conceivable wireless conditions met with at sea. The user can set the speed of the records to suit his present rate and increase it as he improves in reception. Those who have not obtained the proficiency required for the first-class P.M.G. Certificate should bear in mind that there are aids such as these and make profitable use of their spare time on shore.

Indifferent handwriting should also receive attention. Nothing looks worse than bad or ambiguous writing on a telegraph form. Like sending, improvement in this art can only be effected by one's own endeavour. Legibility is of primary importance.

An easy, fluent style of caligraphy can be cultivated by holding the pencil in a comfortable position, the hand turned slightly inward, or to the left, with the wrist raised and supported by the third and little finger. With a little practice it will be apparent that good rapid writing, which is half the battle of good reception, can thus, with perseverance, be acquired. Otherwise, if the wrist be not supported in this manner, the writing will be slow and laboured, and the penman will become easily tired. The disease known as " writer's cramp " is caused, nine times out of ten, through ignorance of how to write properly, the result, usually, of lack of sound training in early life.

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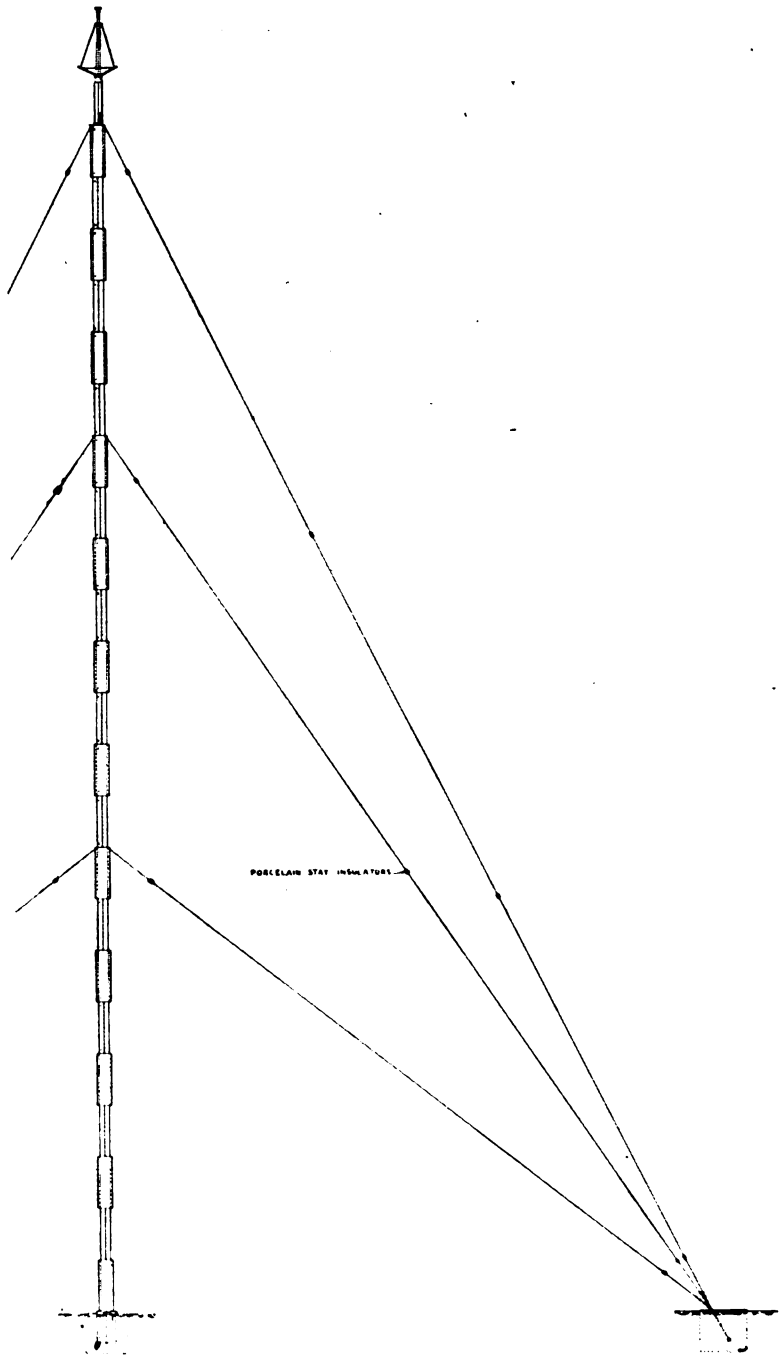
Sectional Steel Mast.



Elevation

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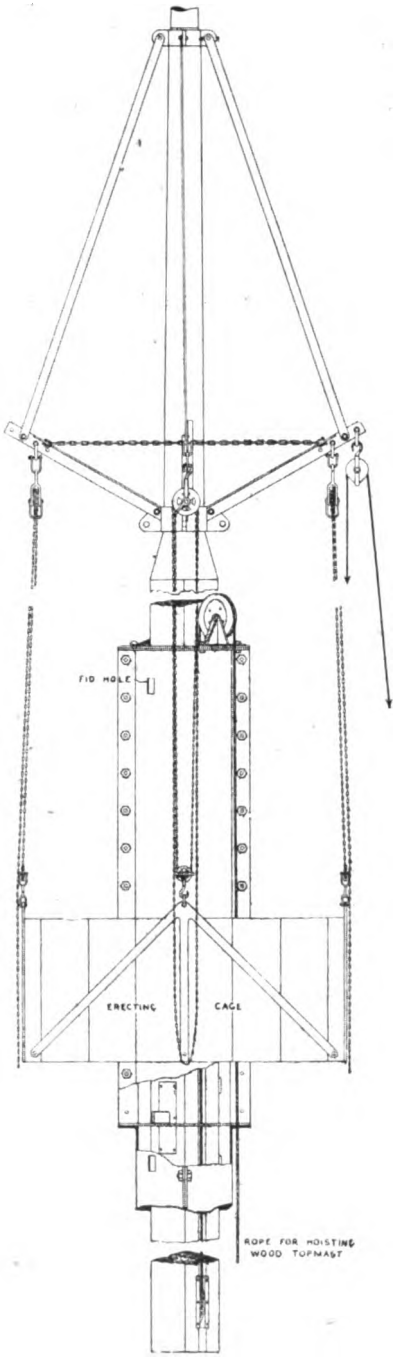

Method of Erection

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Avanti !

Italy Promulgates a New Wireless Magazine

UNDER the title of *Le Vie Del Mare e Dell'Aria*, there appeared in the course of July last the first issue of a new Italian wireless magazine, to which we accord a most cordial welcome.

The editor tells us his conception of the task he sets before himself and the objects of the magazine in his opening article headed " The New Struggle." He claims that, in naming his journalistic venture " The Way of Sea and Air," he is doing more than giving a name ; he is putting forth an act of faith. He enlarges upon the immense scope for energies, to a large measure latent to-day, which will be given free play on the coming of peace : this magazine purposes to stimulate those energies and to record their achievements. It makes its appeal, says he, in his eloquent Italian manner, to men of good faith, to those who can look across the present booming of cannons and vortex of war, to the wide spaces beyond.

A new photograph of Senatore Marconi, in his naval uniform, fitly occupies the place of honour, faced by an autograph letter signed by the great Italian and reproduced in facsimile. The text thereof—translated from the original Italian—runs as follows :—

> In the summer of 1895, from the lofty mountain of Oropa, whilst contemplating the countryside around Biella, I dreamed of how men might find in space new energies, new resources, and new means of communication.
>
> The free way of Space, open for the transmission of human thought, has ever since exercised an intense fascination for my mind. Therein exist inexhaustible sources of inspiration for labours, always new, which may tend to benefit humanity.
>
> I trust that the sons of Italy, who—in emulation with those of other nations—have at all times displayed exceptional capacities for advancing the progress of civilisation, will rise to new and still more lofty heights in the conquest of the Free Ways of Sea and Air.

The magazine runs to ninety-six pages, of which the first thirty-two are devoted to subjects of general interest, whilst twenty-eight concern themselves with technical articles and fifteen treat of miscellaneous subject-matter. The rest of the pages are filled by current announcements together with personal and literary notes.

An editorial note at the end of this issue states that answers to correspondents, whose communications are invited, will be dealt with in subsequent issues.

It would be difficult to attempt a detailed critique in the space which we have available. But it is impossible to pass over, without mention, such exceptionally interesting matter as is contained in the article on " Long Distance Radiotelegraphy, wherein the Marquis Luigi Solari records a number of outstanding incidents in the history of this fascinating feature of wireless development.

He deals with the invention of the magnetic detector, and gives an illustration of the first instrument constructed by Marconi. Incidents connected with the reception of long-distance wireless by the Italian admiral, Mirabello, on the *Carlo Alberto* follow ; and the illustrations include a reproduction of a radiogram in the handwriting of the admiral himself. We are especially glad to note that there are more of these reminiscences to follow.

Amongst the various contributions included in the technical section, we find Signor A. Guidoni's freely illustrated article on " American Efforts in the Development of Aviation," with a chart showing the distances and probable routes of commercial flying after the war ; " Telephony in the Old and New World," by C. J. Giannini, and " Radiotelegraphy at Sea," by G. Lovisetto.

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Wireless Telegraphy In the War

Diplomacy by Wireless.

We have recently seen in the daily Press paragraphs containing the text of official communications from the Governments of France and Great Britain addressed to the *de facto* rulers of Russia. This is nothing less than diplomacy by wireless, and marks an altogether new departure in the history of international relations. One of our morning contemporaries points out that, owing to the fact that the cable lines are at present in enemy hands, telegraphic communication with Russia is only possible through the means of wireless. As a matter of fact, ever since the introduction of radiotelegraphy into general use, diplomatic messages, in common with news items and trade communications, have been transmitted through the agency of this modern innovation. Under former conditions, however, such messages have followed the usual channels of diplomatic intercourse, and have been addressed to the foreign representatives of the countries whence the communications come. What constitutes the real novelty is that, under present circumstances, wireless is conveying messages direct from one Government to another. True this new situation is due to the concatenation of a number of circumstances over and above the one above referred to. One important item of causation consists of the fact that the Allied Governments, obliged by their own national interests to refuse official recognition to the Bolshevik authorities, find themselves without not merely the regularly accredited diplomatic representatives but also without the ordinary substitutes for it, who are having their full share of the troubles caused by the present chaotic condition of Russian internal affairs. Nevertheless, whatever the reason, the introduction into diplomacy of this novel procedure remains as an established fact; and the development is not without notable significance, especially when we come to review the line taken up by the Bolsheviks themselves from the moment of their first entry into power.

Bolshevik Wireless Policy.

It will be remembered that the original Russian revolutionists initiated their movement for the overthrow of the Czar by capturing the allegiance of the telegraphic services, both wired and wireless, and thus rendering it impossible for supporters of the *ancien régime* to take concerted action. In this case, however, wireless merely shared in a general policy affecting all classes of communication. But the Bolsheviks have gone much further in their attitude towards radiotelegraphy. As soon as they succeeded in seizing the reins of power they deliberately selected this medium for making the first announcement thereof, and our readers will doubt-

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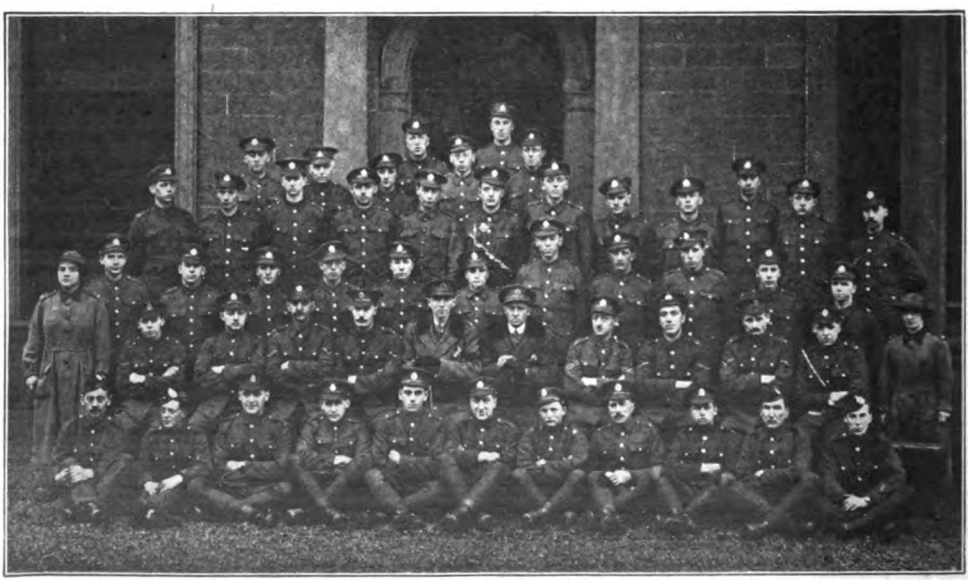
less recall the fact that in November, 1917, they radiated what they were pleased to call "a Formal Offer of Armistice to all Nations involved in the War—to the Allies and also to the Nations at War with us."

They have consistently followed the same procedure ever since. When they desired to change the commander-in-chief of the Russian Army they issued a wireless message "To all Committees of Regiments, Divisions, Corps, Armies; to all the Soldiers of the Revolutionary Army, and to all the Sailors of the Revolutionary Navy," announcing the steps they had taken, the new commander they had appointed, and the reasons for their action. What constituted to all intents and purposes a protest addressed to the Allied Governments for their diplomatic note in relation to the Pact of London was issued in the form of a proclamation radiated from their wireless stations. A similar course has been pursued by them all along: when they desired to indicate their food policy, to convene at Petrograd a general congress of the Russian forces, when they had decided upon a definite date for their armistice, and in fact at every step of any importance which they took. The leaders of the movement professed in set terms to have a horror of "Secret Diplomacy," and Trotzky, who styles himself "People's Commissionary for Foreign Affairs," made a virtue of conducting by wireless telegraphy in plain language every communication that passed between himself and his coadjutors all through his long-spun negotiations with the German representatives. He claimed that thus he was carrying out Bolshevik principles in practice, and conducting negotiations with an "Open Door." It is true that sceptics have pointed to the fact that a large number of the crucial passages in such communications were transmitted in such a way as to be unreadable or incomprehensible; but, whether we grant the sincerity of his attempts or not, the carrying out of diplomacy by wireless still remains a definite and declared policy of the Bolshevik authorities.

RECIPROCITY AND A SUGGESTION.

Such action on the part of the people in power in Russia was not likely to remain long an isolated phenomenon. We accordingly find, early in December, 1917, that Count Czernin, then the Austro-Hungarian Minister for Foreign Affairs,



A WIRELESS SECTION "SOMEWHERE IN ENGLAND."

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answered the Bolsheviks' official radiogram by a diplomatic message from his own Government transmitted through the same medium. We now find Mons. Pichon, the French Minister for Foreign Affairs, protesting by wireless against the conduct of the Bolsheviks in imprisoning Allied Consuls, and demanding their immediate release, as well as facilities for enabling them to quit the country. Great Britain, when faced with the murder of Captain Cromie, the British Naval Attaché at Petrograd, resorted to the same medium for conveying their own demand for reparation and threats of reprisals. Circumstances have therefore forced wireless into the position of a regularly accredited medium for diplomatic intercourse, and it is assuredly a significant sign that this should occur simultaneously with openly expressed feelings of repugnance on the part of democratic peoples against the secret agreements at whose doors it is the fashion of the day to place responsibility for many past calamities.

Incidentally it may be remarked that—in view of the increasing reliance upon radiotelegraphy for official as well as other information—it might be not inadvisable for our own Government to institute more active steps in its extension. Take, for instance, the present situation with regard to Russia. To a large extent we are, under present circumstances, precluded, both officially and generally, from letting the Russian people know what we ourselves are doing, and from learning what is actually going on in those vast territories. Now that a British expedition, despatched in aid of Russian patriots, has actually established itself on the Murman coast, it would be quite possible to erect an important station in that friendly territory capable of transmitting and receiving messages from the different centres in Russia and in constant touch with our own authorities in London. The advantages of such an institution are obvious, and we are not aware that the execution thereof presents any insuperable obstacles.

More About Spies and Wireless.

During the course of the debate in the Upper House, when their lordships were discussing the British Nationality and Status of Aliens Bill, the Earl of Meath made what one of our contemporaries characterised as a "sensational statement," when he mentioned that "there had been Germans in our Navy actually working the "wireless on warships during the war until they were discovered."

We cannot help feeling some cynical amusement at such a statement forming any subject of surprise or "thrill." We have to deal with an enemy who prepared, through long years of peace, for a war which he intended to make inevitable. Spy organisation would naturally form part of such preparation—we usually call it "Secret Service," by the way, when we mention our own arrangements. Naturally such an important item as the British Navy would not escape the attention of the foe, and the wireless section thereof must inevitably be one which would (to employ a pregnant gallicism) "jump to the eyes."

Diligent search for such activities would constitute an important item at the start of active operations, and a certain time must necessarily have elapsed before all could be completely eliminated.

The same remark holds good with regard to every form of illicit enemy endeavours to secure information, and we observe in one of our American contemporaries a note concerning the recent discovery of two suspected spying wireless stations recently raided in Chicago. One of these is described as a "powerful affair for "sending, located on top of a large office building inside the Chicago Loop district"; the other appears to have been an installation designed for receiving only, and located on the north side of the city.

The accompanying map with its numbered squares is a reproduction of part of a German map discovered in Norway, and, lately released for publication by the

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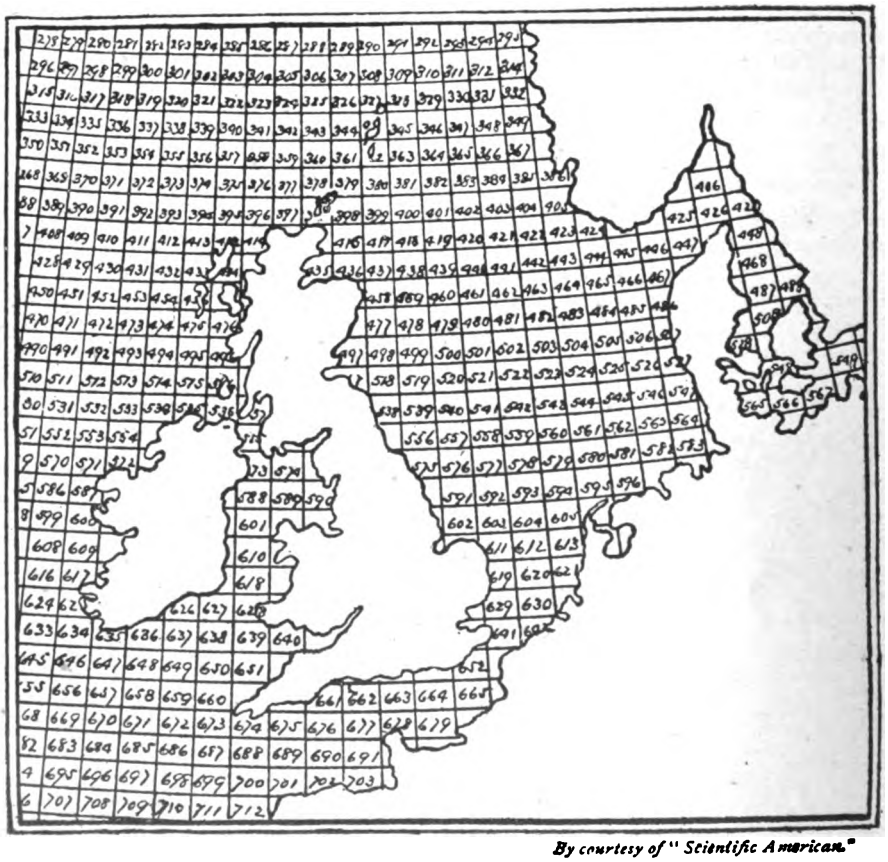
French censor, shows how the German navy plotted the North Sea and English Channel for the use of its submarines.*

By the use of a special code, the departure of every vessel, its tonnage, speed, route and whether it was a ship of commerce or of war, was wirelessed to the submarine by spies in certain coast towns of the adjacent waters. Mr. Henry Barby, writing in *L'Illustration*, gives the following translation of this code, and, as will be seen, it is so designed that every message shall seem to refer to some innocent commercial transaction.

The nationality of the vessel is indicated by first, second, third, or fourth quality, meaning in that order, British, German, French, or Russian, while neutral shipping is designated by colours, such as Norwegian, painted black; Swedish, painted blue; Danish, painted red.

The description of the vessels is designated in the following way: Wooden Box, Series 1, means a warship with one smokestack. Series 2, two smokestacks, and so on. Packing case, Series 3, means armoured cruiser, three smokestacks. Metal box, Series 2, 3, or 4, means light cruiser, two, three or four smokestacks. Barrel, Series 2, 3, or 4, means destroyer, two, three, or four smokestacks. Barrel, Series 1, means a torpedo boat, while the submarines are designated as "samples" and mines as "packages." The position of the boat is indicated by the number of the square on the map, thus a wireless reading "First quality packing case, Series 4, "No. 432," translated, is "British armoured cruiser, four smokestacks, in square 432."



By courtesy of "Scientific American."

* We are indebted to *Flying* for permission to reproduce this here.

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Wireless in Turkey

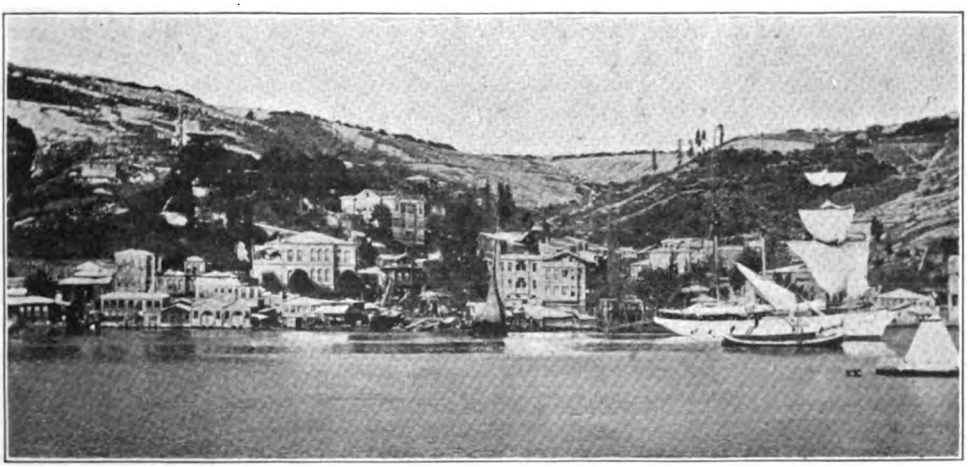
An Amateur's Experiences

By W. GORDON CAMPBELL

(*Continued from page 309 of our September Number.*)

WHILE the foreign warships lay at the mouth of the Bosphorus, close to the Sultan's palace of Dolma Baghcheh, they formed an imposing spectacle which greatly impressed the Turks. It was the first occasion since the Russo-Turkish war, when Disraeli sent a British squadron up to protect Constantinople, that the people had an opportunity of seeing such a fleet of powerful modern warships, and the effect upon them was most salutary. They realised that the guns of these ships could soon lay their city in ruins, if thought necessary, and that in the event of any trouble arising the available army of many thousand bluejackets would make short work of any resistance the Turks could then offer. Therefore, in spite of the threats of the fanatical section of the Mohammedans, no attempt was made to molest the Christians.

The warships were open to visitors on certain days, and thousands of the population, even including some Turks, availed themselves of the opportunity of inspecting them. I myself was specially interested in the wireless installations on these ships, and was fortunate enough to obtain permission to see the apparatus on the French, Italian, and Russian warships, as well as on the small American gunboat *Scorpion*. No one is allowed to enter the wireless room on a British warship without special authority, which is rarely given. The reason, I believe, is that in the British Navy they use special apparatus which they desire to keep secret. But on one of the British ships I was given many useful hints by the officer in charge of the wireless, and two British operators afterwards came to see my installation. The news transmitted nightly from Poldhu was regularly taken down and posted up on the ship's notice board early in the morning. The distance between Poldhu and Constantinople is about 2,000 miles in an easterly direction, so that the difference in time is about 2 hours. The signals sent out from the Cornwall station about midnight were



THERAPIA, A FAMOUS SUMMER RESORT NEAR THE ENTRANCE TO THE BLACK SEA.

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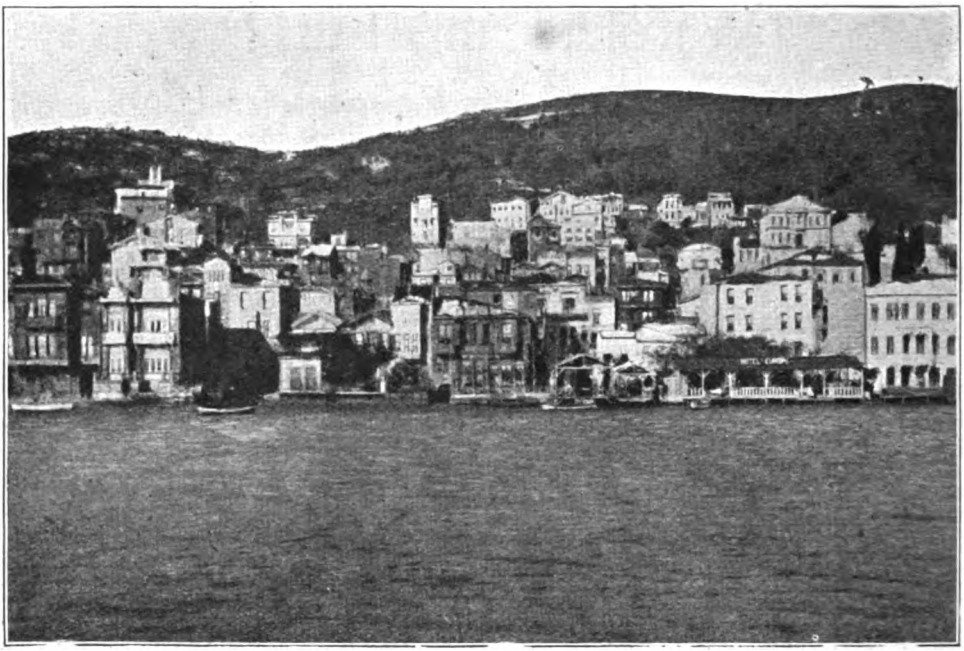

BUYUK-DEREH (*Great Valley*), A CLEFT IN THE HILLS ON THE EUROPEAN SIDE OF THE BOSPHORUS NEAR THERAPIA.

therefore received about 2 a.m. according to local time. The operators informed me that they had no difficulty in hearing the signals over that long distance. On the French *Jules Ferry* I was told, after some hesitation, that I might go into the wireless room for five minutes only; but once there we had a most interesting conversation, and I was pressed to remain as long as I pleased. On this ship they relied mainly on the electrolytic detector, but also used galena. They showed me a large block of this mineral in which they could not find a single sensitive spot. I gave the operator a piece which I happened to have in my pocket, and which, on testing, he found excellent. In return he presented me with one of the platinum "points" or thin glass tubes used in the electrolytic detector, which they themselves had prepared; and I used this with satisfaction for many a day. On the Italian ship *San Marco* the detectors in use were the Marconi "magnetic" and carborundum. The officer in charge here started the transmitting gear for my benefit and sent a few signals. One evening this officer visited my rooms in Pera and examined my installation. On returning to his ship he was good enough to transmit to me a short message. The installation on the Russian ship *Rosdislav* was a very poor one. The spark-gap was fitted over a huge Leyden jar contained in a tall wooden case like a grandfather's clock, and the headgear consisted of only one telephone receiver. On the American gunboat the apparatus was of the Fessenden type.

The harbour of Constantinople is one of the finest in the world, and the first view of the city, as the visitor approaches from the Sea of Marmora, is particularly charming. To the left lies the native quarter of Stambul, with its multitude of picturesque mosques and their delicate minarets. Then directly in front, on the other side of the Golden Horn, lies Galata, the commercial quarter, which is connected with Stambul by a pontoon bridge, as the water is here over 20 fathoms deep, and no other kind of bridge could very well be erected there. Over this bridge there passes a continual stream of people of almost all nationalities,

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in all kinds of picturesque garb, and if the curious visitor were to stand on this famous bridge for half an hour and listen to the passers-by he might hear between twenty and thirty different languages. Behind Galata the ground rises steeply towards Pera, the European quarter, and is dominated by the old Genoese tower known as the Tower of Galata, from which a magnificent view of the whole city can be obtained. Here men are on watch day and night for outbreaks of fire, which are so destructive where the houses are mainly built of wood. When a fire is observed signals are hoisted on the tower and the "bekjis" or night watchmen go through the main streets as well as the outlying villages shouting, "Yangin var" ("There is a fire"), with particulars of the locality. Farther to the right lies the entrance to the Bosphorus, a deep channel about fifteen miles long and from three-quarters of a mile to two miles wide leading northwards to the Black Sea. The ground rises abruptly on either side, and the succession of marble palaces and other picturesque buildings, some of which overhang the water, that meet the eye at every turn help to create a veritable fairyland of which the eye never tires. The water is so deep close up to the very edge that great steamers may pass within a few yards of the shore; indeed, on one occasion a passing vessel, on which the steering-gear went suddenly wrong, pushed her nose right into a Turkish harem before the engines could be stopped. What a fright the ladies must have got! The declaration of one of the sailors that when the vessel backed out they found a fair odalisque sitting astride the bowsprit is believed to be untrue.

As everyone knows, there is very little tide in the Mediterranean. At Constantinople the water is always at the same level except when a strong south wind, driving it up from the Sea of Marmora, raises it by a foot or so. There is, however, a strong current which usually flows down from the Black Sea, and there is also an

A PRETTY BAY NEAR THERAPIA.

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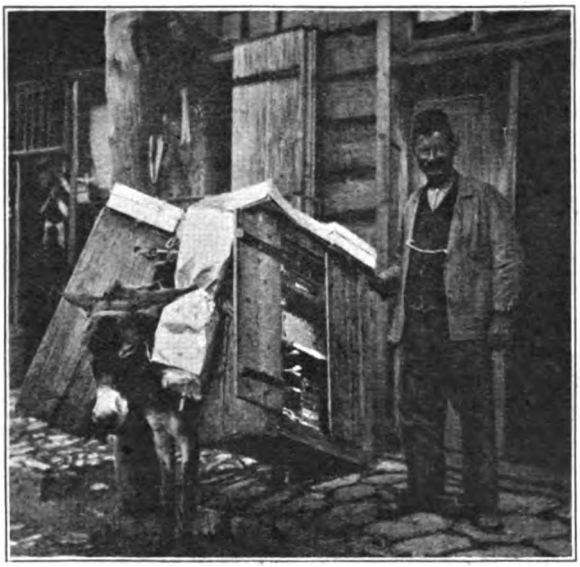

TRAVELLING HABERDASHER IN TURKEY.

undercurrent flowing in the opposite direction. A curious experiment was once carried out here by an English naval officer. He constructed two wooden boxes connected together by a rope, of which one floated on the surface, while the other was weighted so as to catch the undercurrent. On that day the lower current was the stronger, and the Turks were astounded to see the floating box sailing up merrily against the surface current without any visible cause. They decided that the devil must have had a hand in it.

About half-way up the Bosphorus, at its narrowest part, we see, on the European side, the old towers of Rumeli Hissar, built by Mohammed II., after crossing at this point, shortly before he captured Constantinople in 1453 and set up the Crescent in place of the Cross over the famous church of St. Sophia. There is at last a prospect that the Christian emblem may soon be restored. I lived for three years at Rumeli Hissar, high up on the hillside, from which there was a magnificent panorama of the Bosphorus and the continuous procession of ships that passed to and from the Black Sea. Not far from the Black Sea entrance lies Therapia, where most of the Ambassadors pass the summer months, and which is then the centre of fashionable European life. Adjoining Therapia, on the other side of a small inlet, is Buyuk-dereh, shown in the photograph, which is also a favourite summer resort. Across the Bosphorus, directly opposite Therapia, lies the Bay of Beicos, from which a winding and steep road leads up to the summit of Yusha Dagh, or Joshua's Mountain. Here the visitor is shown what purports to be the grave of the Prophet. It is over 30 ft. long, so that we must conclude that there really were giants in those days. This mountain commands the entrance to the Bosphorus from the Black Sea, and from the top a magnificent panorama of the Strait is obtained.

The tomb is surrounded by a railing, on which the devout hang up rags of clothing after repeating a prayer, as a sort of reminder to the Prophet that they seek his favour. A short distance south of Beicos the mother of the recently deposed Khedive used to live, and on the hill behind her residence he erected, a few years ago, a beautiful Kiosk or summer palace, which forms a prominent object on the Asiatic side of the water. During the Khedive's visits to Constantinople his yacht *Mahroussa* used to lie in Beicos Bay, and I often heard the operator speaking in English with Port Said.

When the visitor lands at Constantinople and wanders through the dirty, narrow, and ill-paved streets the charm of the place suffers a good deal. A few years ago one had to pick his way over sleeping dogs, which had a distinct preference for the pavement as a resting-place, but these are nearly all gone now. Their end was indeed sad. When the Turks decided to clear the streets of these animals they transported them to a small rocky island in the Sea of Marmora and arranged with certain men to provide them with food and water; but these men, after pocketing the money given them, entirely neglected the dogs, which all died of starvation or disease to the number of about 15,000.

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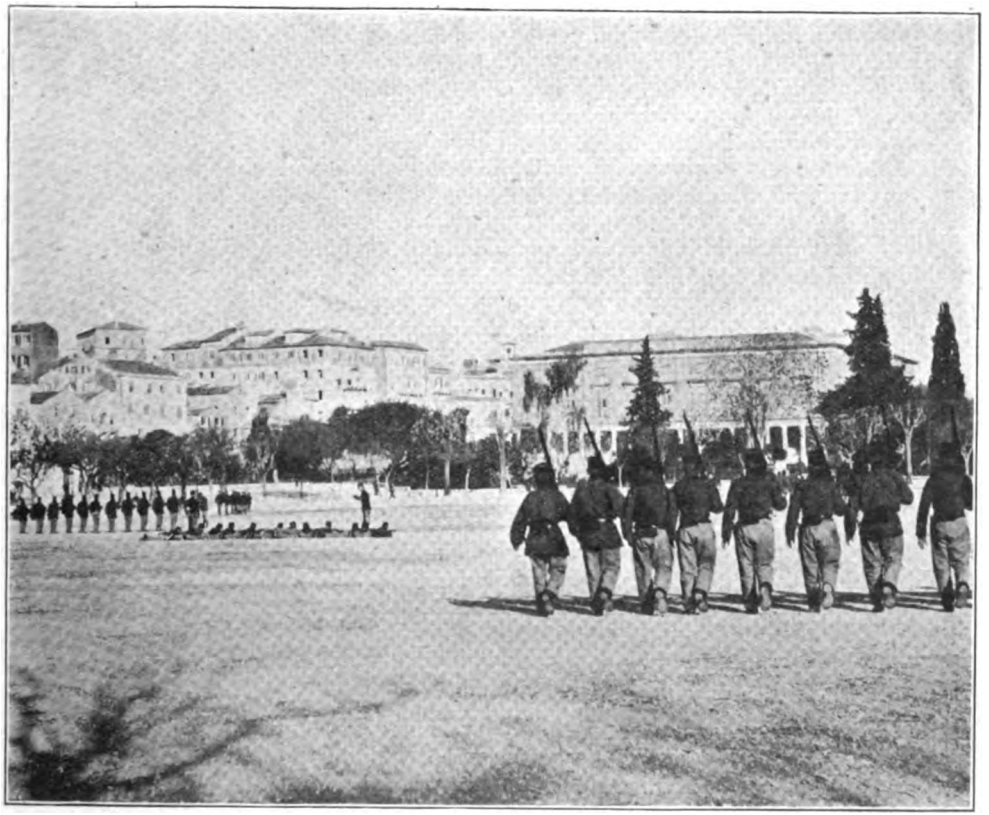
A great deal of the trade in fruit and all kinds of small goods is carried on by itinerant vendors, with and without the inevitable donkey, and their voices may be heard everywhere shouting or singing their strange cries in both Turkish and Greek.

It would require a volume, instead of a short magazine article, to give an adequate description of this wonderful city and its surroundings, and I have therefore only indicated a few of the most interesting features.

As soon as Turkey decided to join in the war a "law" was issued prohibiting the use of wireless, and my installation was at once dismantled. I was obliged to hand over my instruments to the police, but for some reason I was still suspected of having secret apparatus, and they made several unexpected visits to my rooms. Meantime several persons had been arrested on mere suspicion, or because a child in the house had some electrical toy. The police knew nothing about wireless, and assumed that any toy apparatus could be used to "communicate with the enemy" outside the Dardanelles. My own position having become decidedly dangerous, I resolved to leave Turkey if I could, as many British subjects had already done, and with some difficulty I was eventually able to cross the frontier into Bulgaria. I was, however, obliged to abandon most of my belongings. It was well that I did so, as I subsequently learned that a few hours after my departure the police had again visited my rooms; but on seeing my books and papers lying about as usual they little suspected that I was then *en route* for Dedeagatch, where I duly arrived with a crowd of other fugitives. From that port I proceeded a few days later to Piræus and Athens.



TURKISH SOLDIERS AT DRILL.

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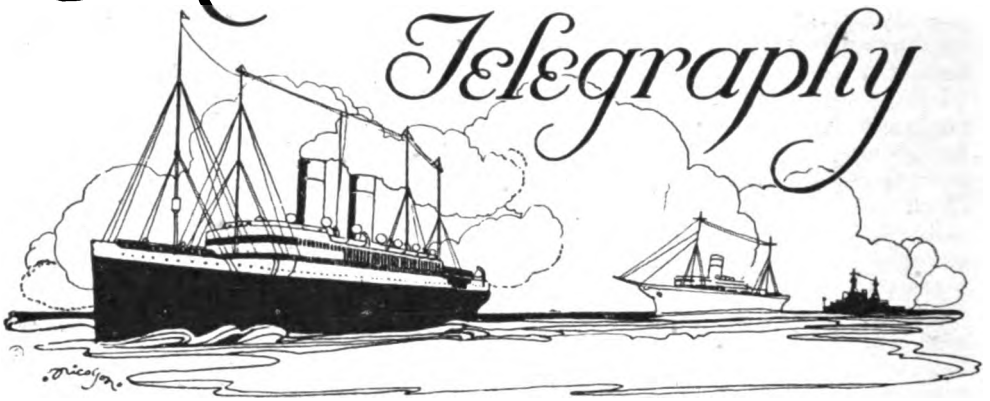
Maritime Wireless Telegraphy



WIRELESS FIGHTING THE SUBMARINE MENACE.

To under-rate *any* enemy effort constitutes one of the most prolific sources of disaster in waging war. Our German foes have erred in this way many a time and oft; perhaps never more conspicuously than in the spring and summer campaign of the present year.

The anxious times through which the British authorities passed during the height of the U-boat menace arose very largely from the same cause. In its initial stages, German submarine warfare was treated as a side-show, troublesome at intervals, but not of paramount importance. So soon as the problem was tackled in earnest, British ingenuity and intrepidity speedily manifested its superiority. At the same time, it can never be too persistently emphasised that there is no panacea for the pest; the evil is being remedied solely by the consistent and ceaseless application of *all* the various means at our disposal. Wireless plays a prominent part amongst these antiseptic agencies, a fact which is well brought out by the following recently released story of aerial activities.

* * * * * *

The commander of a British airship received orders to relieve a sister vessel watching over a "suspected area." So soon as he found himself in the air, he started attempting to locate his consort's position by means of wireless, and speedily effected his object, with the result that the earlier watcher returned to her base. After a period of uneventful watching, the look-out spotted a German craft lying "doggo" on the bed of the ocean. Wireless immediately came into action again; and, summoned by the ether waves, a lithe destroyer put in her appearance, bringing in her train four squat armed trawlers. The gun-crew of the destroyer, guided by wireless instructions, trained their guns in readiness to greet the foe should he rise.

In the meantime, the trawlers reached the scene and set to work in their own way. Organised in pairs they approached their prospective victim from opposite directions, steaming towards each other. Between each pair stretched a strong "sweep" allowed to hang in a huge loop so that it might traverse the sea bed. In due course each pair succeeded simultaneously in entangling the U-boat; one loop holding her forward and one aft. Thus she was, as it were, "rocked" in a gigantic "Cradle of the Deep"!

So far the German underwater craft had shown no signs of alarm; but now—immeshed in the tentacles of her foe—she writhed to and fro, making frantic but

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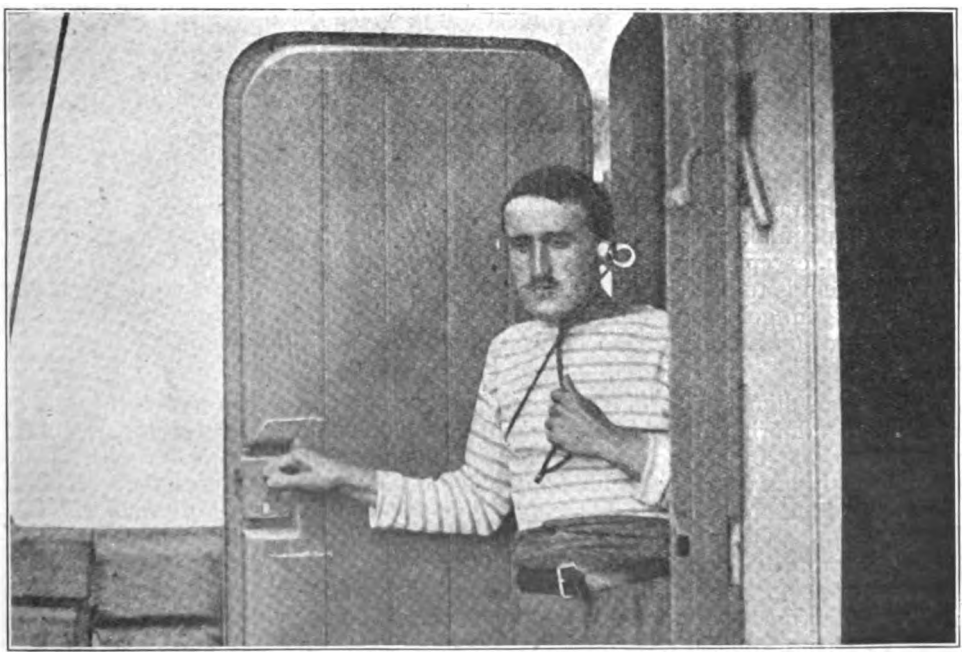
useless endeavours to escape. At length, realising her helplessness, she ceased to struggle. The watchers on the airship, observing her quiescence, duly wirelessed the fact to the destroyer below. The British commander paused for a few minutes to give the U-boat commander an opportunity of rising to the surface to surrender. This opportunity was not taken; and in response to a flagged signal from the destroyer, the starboard foremost trawler, and the port one aft, each attached a tin of high explosive to their respective "cradle wires," sliding the mine downwards until it rested on the pirate's hull. Again a signal from the airship, and the two firing keys were pressed. A greyish mound of water rose; and, when the troubled ocean calmed again, nothing of the submarine was to be seen save an extensive patch of oil floating upon the surface of the water.

* * * * * *

The same tale of wireless at every turn is told in all the yarns which concerned themselves with the hunting of German sharks, unless the narrator be so *blasé* to its services as simply to take them for granted. For instance, one British correspondent, describing his voyage on a French destroyer, carrying the Admiral in command of the local operations, has nothing to say about radiotelegraphy until a point in his story when he comes to describe how the French commander accounted for lack of luck by showing him a wireless message from a sister boat which claimed to have "put down" a German submarine thirty miles away. The Admiral's staff on the French destroyer remained a little sceptical of the claim, and the second-in-command made the following remark:—

"They often claim that they have done for the submarine; but it is our staff's "job to be healthily sceptical. That wireless about the German craft thirty miles "away came to us and to every other warship on this beat. Such radio messages "arrive very frequently, much more so probably than the German submarines "imagine. The methods of detection by wireless now in use are much improved "and very accurate."



A FRENCH WIRELESS OPERATOR AT THE DOOR OF HIS CABIN.

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Notes of the Month

A Wireless Alibi.

Lovers of Dickens will recollect how Sam Weller's father advised Mr. Pickwick, when the latter was preparing his defence against Mrs. Bardell's action for breach of promise, to "Try 'em vith a halibi." This traditional method of defence was, according to the *Montreal Herald*, recently utilised with great effect in favour of a certain Mandal Moosa, a Hindu magnetic doctor, charged with a theft of jewellery. The defendant pleaded an alibi which Judge Leet considered important enough to warrant investigation by wireless. Messages were accordingly radiated to and from a vessel on the high seas which established to the judge's satisfaction that the ship's log registered Moosa's presence on board at the time when the complainant averred him to have been in her house. The alibi thus "made good" sufficed to give the accused the benefit of the doubt, and—for the first time in the Montreal Courts—a prisoner was set at liberty through the intervention of wireless.

Board of Trade Announcement.

No little satisfaction has been given by the following announcement recently issued from the Board of Trade :—

> The King has approved of a special medal being granted to Masters, Officers and seamen of the Mercantile Marine for services performed in the danger zone during the war. The medal will be issued at the end of the war, and clasps will be awarded where conspicuous service has been rendered.
>
> His Majesty has also approved a standard uniform for the Mercantile Marine, and an Order in Council on this subject will be issued shortly.

Particulars concerning the National Standard Uniform for the British Mercantile Marine are given in the *London Gazette*, dated September 6th, page 10,533, and we find Wireless Operators included amongst those specifically named as entitled to wear the insignia, which are forbidden to those not qualified.

The First Wireless Operator is entitled to a distinctive badge of two waved lines with a diamond; the Second Operator to the same without a diamond, and the Third Operator to a single waved line. These lines may be in ¼-in. gold Russian braid or in plain black braid. The space between each row of lace, mohair, or braid, is to be ½ in. except in cases where there are two rows only, in which case the space between them is to be 1½ ins. The one diamond borne by First Wireless Operators is to be of ¼-in. gold Russian braid (or block braid) with open centre and an outside measurement (angle to angle) of 1½-ins. imposed on the distinction lace.

Dignity and Impudence.

Castilian dignity is proverbial, and the present writer has had many opportunities of admiring it. A series of curious contrasts has been afforded during the present war by the conduct of the German Government *vis-à-vis* with Spain. Only the other day one of the most prominent of German newspapers, the *Koelnische Zeitung*, was taking King Alphonso's Ministers to task for threatening to seize German ships, and characterised such an act as "one of gross violation of neutrality." Yet all the time Germany claims that she may sink Spanish ships with impunity! For downright and unmitigated impudence, however, we think that the wireless message sent by the Teutons to the new Spanish Minister, Señor Lopez de Vega, when *en route* to take up his official duties in Athens, would be hard to beat. His Excellency received at dinner a wireless message announcing that Austro-German submarines would sink the vessel he was travelling by, but would take precautions for his personal safety!

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On Valve Characteristic Curves and their Application in Radiotelegraphy

By J. SCOTT-TAGGART, R.E.

II.

NOTE.—*The first instalment of this article appeared in our September issue, p.312 et seq.*

FIG. 5 shows the original curve, and also a similarly placed but larger curve obtained by correctly balancing suitable values of filament current and high-tension voltage.

From the above we see that, by judicious adjustment of filament current and high-tension voltage, we can vary the nature of the characteristic curve and arrange to have it completely to the left of the zero ordinate, almost completely to the right, or at any intermediate position. We have also seen that once we have obtained the desired curve by means of these adjustments, no matter what its position or height, we can use the valve at any point on that curve by adjusting the normal grid voltage to the necessary value. Thus, if we desired to work the valve at saturation point, and we have $3\frac{1}{2}$ volts across the filament and 6 volts on the plate, we would have to give the grid a normal positive potential of + 11 volts. If, on the other hand, we have 154 volts on the plate, we would require a negative potential of −7 volts on the grid to make the valve function near its saturation point.

Let us now examine the curves with a view to finding out what curve, and what point on it, is the most suitable when we desire to use the valve as an amplifier.

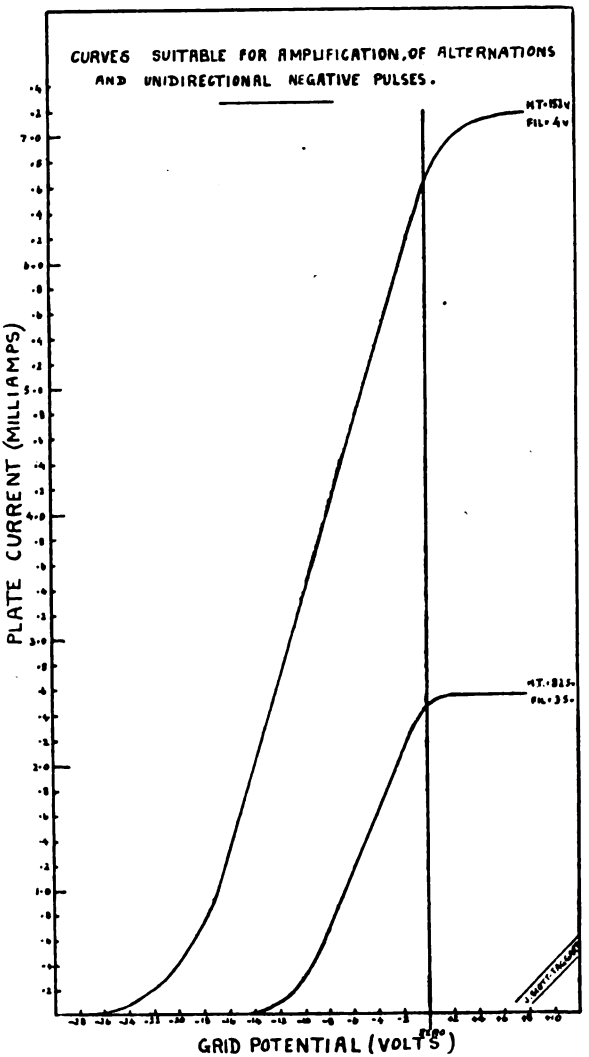
CURVES SUITABLE FOR AMPLIFICATION, OF ALTERNATIONS AND UNIDIRECTIONAL NEGATIVE PULSES.
PLATE CURRENT (MILLIAMPS)
GRID POTENTIAL (VOLTS)

FIG. 5.

AMPLIFICATION.

The valve may be used as an amplifier of alternating or oscillating currents, microphonic currents produced by speech, or intermittent unidirectional pulses. The circuits used for these purposes have been described by the writer in previous

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papers ; * it is now proposed to look more closely into the question of amplification from a quantitative as well as qualitative standpoint.

Fig. 6 shows a suitable circuit for low-frequency amplification. The potentiometer P enables us to give the grid a normal potential on either side of zero. The voltage of the original alternating current is stepped up by means of the transformer T before influencing the grid, its final value, let us suppose, ranging from + 3 volts to −3 volts.

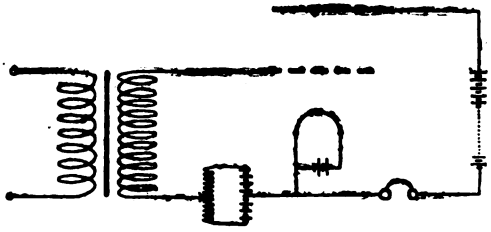

FIG. 6.

Let us also suppose that we are using our valve under conditions that give a characteristic curve similar to the E curve of Fig. 3. This curve is obtained by placing 3½ volts across the filament and 33·5 volts on the plate.

If we keep the grid voltage zero, the negative half of each alternation will cause the grid voltage gradually to drop to −3 volts, and then to return to its normal potential. As the positive voltage builds up on the grid—due to the positive half of each alternation—a grid current will be set up, since the grid is at a higher potential than a portion of the filament. This flow of negative electrons will tend to neutralise the positive charge that the positive half-cycle is trying to place the grid. In other words, the grid current prevents to a certain extent the rise of grid potential, just as the E.M.F. of a cell drops on completing the outer circuit. The result is that the positive half-cycle causes only a slight increase in the plate current, while the negative half produces a drop of about ·8 milliamp.

By using the grid at zero voltage we have produced alternations in the plate circuit of a different nature to the original alternations. We have, in fact, rectified the latter to a certain extent. Since we are trying to reproduce faithfully our original current variations, this rectification effect due to a grid current is a very decided disadvantage. Moreover, it will exist in all cases where there is a tendency towards the establishment of a grid current. If we use a higher value of high-tension voltage, the grid current for 3 volts on the grid is less than before, and the rectification effect is not so marked. It will always exist, however, whenever the grid potential tends to acquire a positive value.

In order, then, to avoid a grid current we must never allow the grid voltage to become positive. If, therefore, we give the grid an initial potential of −4 volts by means of the potentiometer, the alternating current will vary the grid voltage between −1 volt and −7 volts. Although we now get no complications due to a grid current, by continuing to use the same curve we are still at an unsuitable point for amplification. We are using the bottom bend of the characteristic curve, and, therefore, the increase in the plate current due to the positive half of an alternation or oscillation will be greater than the decrease produced by the negative half. In our special case the increase will be ·45 milliamp, and the decrease ·1 milliamp. We, therefore, still have undesired rectification effects. If we increase the high-tension voltage to 100 volts we will be using a new curve, but this time the −4 volts on the grid brings us to the *upper* bend of the curve, near saturation point. At this point the positive half-cycle produces practically no increase in the plate current, while the negative half-cycle causes a very considerable drop. This time the 3 volts bring the grid voltage to −1 volt, but the plate current is only increased from 2·27 milliamps to 2·58 milliamps, while −3 volts added to the existing −4 volts on the grid cause the plate current to drop from 2·27 milliamps to 1·6 milliamp.

It is, therefore, important that we should avoid either of these bends. In fact,

* *Vide* WIRELESS WORLD, January, February March, 1918.

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if we wish to reproduce current variations with absolute accuracy, it is essential to use straight portions of the characteristic curve. The *steep*, straight portion is obviously the part to use since we get big current variations in the plate circuit for small grid voltage changes. Even if the ordinate passing through the normal negative grid voltage cuts a bend in the characteristic curve, the valve will reproduce fairly accurately current variations *of very small voltage*, but the amplification obtained is small.

From the above it is apparent that, to avoid rectification effects and to obtain the maximum amplification, we must use the steep, straight portion of a curve. We could use the 82·5 volt curve and, by putting a normal voltage of -5 volts on the grid, use it approximately at its half-way point. Equal positive and negative voltages will now cause equal increases and decreases of plate current, and all current variations in the grid circuit will be reproduced on a larger scale without distortion in the plate circuit. Fig. 7 shows the effect of a complete cycle of alternating current of 3 volts amplitude in the grid circuit on the current in the plate circuit, which is shown by a dotted line. Fig. 8 shows us the same results in a different form.

It will be seen from a study of the 82·5 volt curve under discussion that if we use a stronger alternating current in the grid circuit than the one we have so far considered, not only will we be using both bends of the curve, and so produce distortion in our plate-circuit alternations, but we will not be getting the fullest amplification possible with the valve.

Let us suppose that the alternations in the grid circuit have an E.M.F. varying from -8 volts to $+8$ volts. By giving the grid a normal potential of -5 volts we will vary its voltage between -13 and just under $+3$ volts. The effects of this on the plate current is shown in Fig. 9, which shows us the distortion effects, and also shows that the amplified alternations are of not much greater amplitude than those produced by the 3 volt alternations.

From this we see that for a given characteristic curve, or, more simply, for a given value of filament current and high-tension voltage, the maximum amplification obtainable is limited, and is achieved when the varying grid vol-

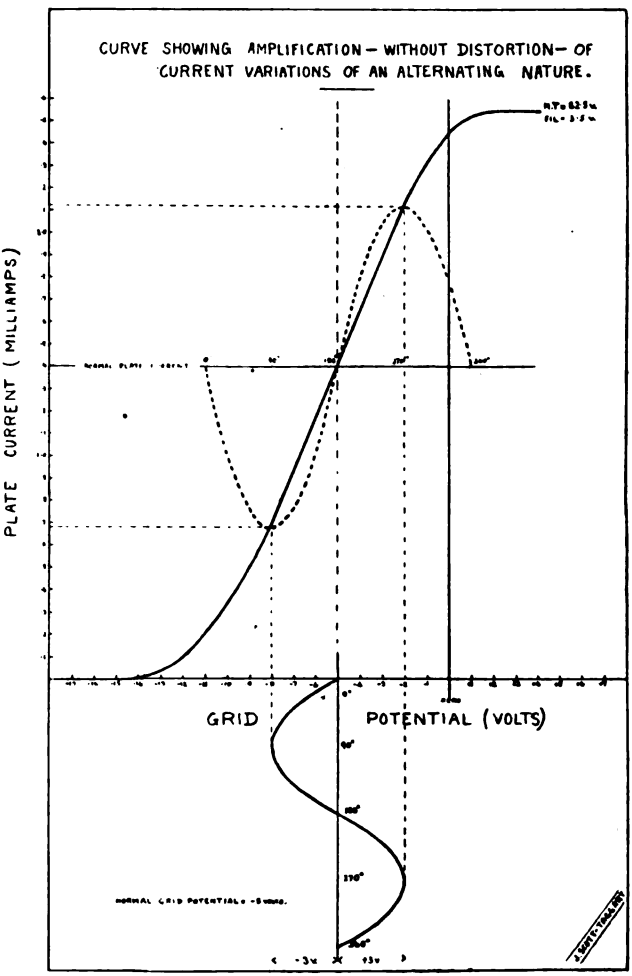
CURVE SHOWING AMPLIFICATION – WITHOUT DISTORTION – OF CURRENT VARIATIONS OF AN ALTERNATING NATURE.
PLATE CURRENT (MILLIAMPS)
GRID POTENTIAL (VOLTS)

FIG. 7.

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tage varies the plate current between zero and its saturation value.

For strong alternations or signals, it is, therefore, desirable to extend the curve vertically. This, we have shown, can be done by increasing the filament current and high-tension voltage. We still, of course, keep the whole of the straight portion of the curve to the left of the grid zero ordinate. Fig. 7 shows the original 82·5 volt curve—which was only suitable for alternations or oscillations not exceeding 3 volts amplitude, and also a higher curve suitable for amplifying stronger current variations. This curve will do justice to our 8 volt alternations, and no distortion effects will be produced. It will, however, be necessary to give the grid a normal voltage of -8 volts in order to use the curve at its half-way point.

Although it is not absolutely necessary to use the valve near the mid-way point along its curve, this is generally done when amplifying alternating, oscillating or microphonic currents. If the current variations are not too strong, we may use practically any point on the straight portion of the curve as our normal adjustment.

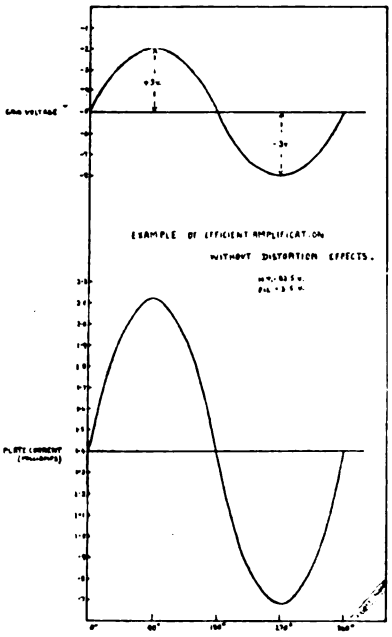

FIG. 8.

The point *B* on the 82·5 volt curve (Fig. 3), obtained by using a normal grid voltage of -9 volts, would be quite suitable when amplifying currents which varied the grid potential 1 volt to either side of its normal value. On the other hand, it would be quite unsuitable for amplifying currents which would increase and decrease the grid voltage by 3 volts.

Thus we see that our choice of the most efficient curve and the most efficient point on that curve is dependent very largely on the *strength* of the alternations, oscillations or microphonic currents which are to influence the grid.

The amplification of unidirectional pulses, such as are obtained from a rectifying detector, is a much simpler matter. Since the current flow is always in the same direction we can arrange matters so that the grid always receives a negative charge at each pulse. Since there will never be a grid current, it is unnecessary to have an initial negative voltage on the grid; we can keep the grid at zero voltage and dispense with the potentiometer. As regards curves, we can use most of those given in Fig. 3, the choice depending upon the strength of the pulses on the grid. The 6 volt curve, however, is inefficient, partly because it would be unsuitable for any but very weak pulses, and

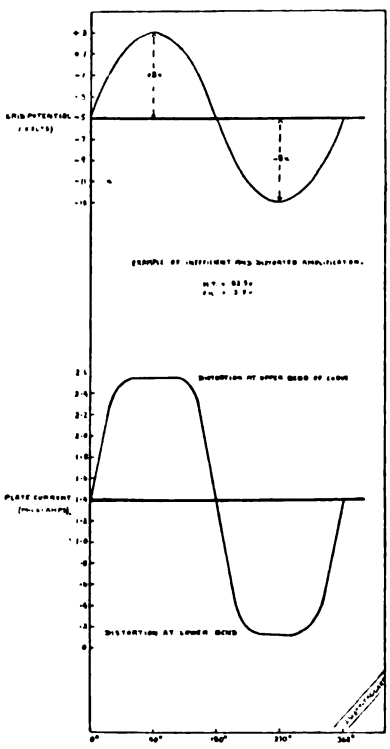

FIG. 9.

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partly because even then the current changes in the plate circuit would be very small, the curve gradient at this point not being steep.

The 33·5 volt curve is capable of dealing efficiently with stronger pulses which would cause the grid potential to drop to values as low as −3 volts. For still stronger pulses the 82·5 volt curve would be suitable. For pulses which would cause the potential of the grid to drop 12 volts but not more, the 100 volt curve could be used. Curves such as the 154 volt curve are practically useless for amplification, since it would take the first 12 volts on the grid to round the saturation bend and produce a drop in plate current of only 0·6 milliamp. None of the curves of Fig. 3 would, therefore, be suitable for amplifying very strong pulses. The large curve of Fig. 5, however, would be very suitable. This curve is obtained by 152 volts on the plate and 4 volts across the filament. This curve would be suitable for *any* grid voltages down to −18 volts, which value would produce a drop in plate current of about 6 milliamps.

If, by mistake, we connected the amplifying valve or valves so that the pulses gave the grid a positive value, we would have to adjust the high-tension voltage and the filament current so that a considerable portion of the curve would be to the right of the grid zero ordinate. The 12 volt curve of Fig. 3 would be suitable. Such an arrangement might be considered economical, since the plate current is normally very small when signals are not being received. However, the amplification obtained is not as great as that given by the reverse connections, for two reasons closely allied. In the first place, the "straight" portions of curves become less steep to the right of the grid zero ordinate, owing to a certain proportion of electrons passing to the grid; secondly, this grid current prevents the potential of the grid reaching its full positive value.

When connecting up an amplifying valve or multi-valve amplifier, the reverse connections to grid and filament should, therefore, also be tried, and the optimum signal strengths obtained in each case noted and compared.

It will have been noticed that when we are dealing with unidirectional pulses it is not necessary to make the valve function near its midway point.

In fact, if we do this, we will be using a curve twice as high as is necessary, and half the curve will never be used. This means that we are needlessly wasting current from the lighting accumulators, and perhaps from the high-tension battery. If the grid is connected so as always to receive pulses which give it a negative charge, a curve of half the height may be used, provided we use it at the upper end of its straight portion. Such a curve is the "D" curve of Fig. 4. This arrangement is almost as efficient and far more economical than using a higher curve like the "C" curve of Fig. 4. Similarly, when we arrange for the grid always to receive positive pulses, we should, for reasons of economy, use the bottom part of the steep, straight portion of the curve. The 12 volt curve of Fig. 3 would be suitable.

For a valve to be efficient as an amplifier of any type of current variations its characteristic curve should, along its straight portion, be as steep as possible. It is important to notice that for a given valve the portions of the curves *used*—namely, the steep, straight portions of curves lying mostly or altogether to the left of the grid zero ordinate—have all approximately the same gradient. The 100 volt curve of Fig. 3 is not quite as steep as the 54 volt curve, but the variations of gradient are never considerable. If anything, the higher curves obtained by large values of filament current and high-tension voltage are the steepest.

Different types of valves, however, vary considerably in the gradient of their curves, and, therefore, in their value as amplifiers. Fig. 10 shows a comparison of the curves of two types of valves, the one having a steeper curve than the other.

Before passing on to a consideration of valve rectification and transmission, let us summarise some of the points already dealt with above.

Different combinations of filament current and high-tension voltage give us curves of different sizes and positions. The position of the point of intersection

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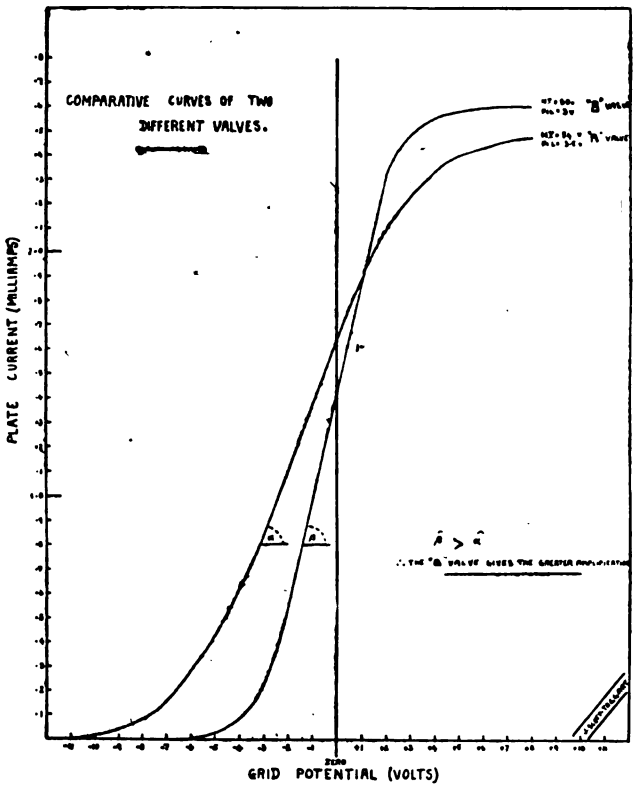

FIG. 10.

where the curve is cut by the vertical line passing through zero grid volts, and which has been termed the grid zero ordinate, is of the utmost importance. For general amplifier work this line should cut the curve just below the saturation bend. The workable portion—the straight part—is then entirely to the left of the vertical line, and no rectification effects are obtained through the establishment of a grid current.

Even more important than the curve's position relative to the zero ordinate is the point at which we work the valve—that is to say, the part of the curve cut by the vertical line passing through the normal potential of the grid, which may be given any value. To find the value of this normal grid voltage most suitable for amplifying currents of an alternating nature we have only to drop a perpendicular line from the midway point along the straight portion of our curve on to the grid voltage abscissa. This negative value may be given the grid by means of a potentiometer included in the grid circuit, no matter whether the grid circuit has in it the secondary of a step-up transformer or an inductance coil. Where a certain amount of distortion in the amplified current variations is not of consequence we can keep the grid at zero voltage by simply connecting it through the transformer or inductance coil to the negative end of the filament. In this case we would arrange the curve so that the grid zero ordinate would cut it at its half-way point. When speech, however, is to be amplified, it is of great importance that we should avoid the slightest distortion. In practice, we could use a couple of dry cells, instead of a potentiometer, to keep the grid at normal negative value, and arrange our curves accordingly.

The characteristic curve may be displaced to the left by increasing the high-tension voltage on the plate. This hardly affects the steepness of the straight portions of the curves, which remains more or less the same for different values. It will be noticed that the curves of Fig. 3 all have their straight portions almost parallel. At the same time, the maximum height of the curve is increased.

The extension of a characteristic curve is practically equivalent to moving the curve to the right. The effect is to make the grid zero ordinate cut through a relatively lower point of the curve. For low values of high-tension voltage the extension of the curve by increasing the voltage on the plate exceeds the actual displacement of the curve to the left. The resultant effect is that the grid zero ordinate cuts through a lower relative point on the curve. As we increase the high-tension voltage the extension produced becomes small compared to the displacement to the left, so that

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the resultant effect is that the point where the ordinate cuts the curve moves higher and higher until saturation point is reached. The above will be more clearly understood by a reference to Fig. 3.

The effect of increasing the filament current is simply to extend the curve without actually moving it sideways. This extension, however, is equivalent to moving the curve to the right, since it causes the zero ordinate to cut it at a lower point.

By increasing or decreasing the filament current and high-tension voltage together we can produce a series of curves all similarly placed with regard to the zero ordinate, but of different sizes, the larger curves being suitable for amplifying very strong current variations.

Before passing on it would be as well to point out that the results given here in graphical form have been obtained by giving the grid steady, *maintained* potentials. In actual practice, especially when amplifying high-frequency oscillations, the potentials given to the grid are only momentary, lasting perhaps for only a millionth of a second. Deductions from the curves must be made with this always in mind, particularly when considering those portions of curves which lie to the right of the grid zero ordinate. This point will be subsequently emphasised more strongly. Later, the writer intends to give details of results obtained by taking oscillographs of the magnified current variations taking place, under various conditions, in the plate circuit of a valve. The present paper is only intended as a broad consideration of some of the more elementary facts. It is hoped later to enter more deeply into the finer distinctions and phenomena in connection with valve characteristic curves.

(*Concluded.*)

London's Lord Mayor Greets Senatore Marconi in Rome

THE RIGHT HON. SIR CHARLES A. HANSON, WHO RECENTLY VISITED ITALY, HAD THE OPPORTUNITY OF GREETING THE DISTINGUISHED ITALIAN SCIENTIST IN HIS OWN CAPITAL CITY.

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Among the Operators

It is our sad duty, month by month, to record the deaths of the brave operators who have lost their lives at sea by enemy action and other causes in the wireless service of their country. Owing to the necessity of preventing the leakage of information likely to assist our adversaries, the names of ships and localities of action cannot be published. With the exception of Messrs. Harold Whittaker, drowned whilst bathing at Civita Vecchia, and James Falconer McArthur, who died from natural causes, the lives of the operators mentioned this month have been sacrificed as the result of hostile activities or disaster at sea.

MR. JAMES DRUMMOND was born at Rutherglen, Scotland, on January 6th, 1894, and educated at MacDonald Public School, Rutherglen. His employment by the several firms of Messrs. Campbell Cameron & Co., Morton & Hume, and T. F. Firth & Co., all of Glasgow, gave him a good business experience, after which he underwent training at the North British Wireless Schools, Ltd., Glasgow. On gaining the P.M.G. Certificate he was appointed to the Marconi Company's staff in July, 1916.

Born at Tottenham, London, on May 27th, 1900, MR. EUGENE JOSEPH O'SULLIVAN was educated at St. Mark's School, Chicago, Ill., U.S.A., St. Ignatius College, Stamford Hill, N., and Clark's College, London. After a period of service in H.M. Paymaster-General's Office, he entered Marconi House School, where he qualified for, and received, the P.M.G. Certificate, and was given an appointment by the Marconi Company last June.

MR. WILLIAM MUNDIE was born at Peterhead on November 20th, 1900, and went to St. Fergus Public School for his education. His training in wireless telegraphy was received at the Marconi House School, and, after obtaining the P.M.G. Certificate, Mr. Mundie commenced his service with the Marconi Company in March last year.

In his eighteenth year, MR. LEONARD JAMES WILLIAMS was born at Plymouth, and received his education at Prince Rock Council School, Plymouth. Whilst employed as a boy messenger at the Plymouth Post Office he occupied his spare time in learning ordinary telegraphy at the Bedford Park Telegraph Training School, and during that period he also passed the examination for a Post Office clerkship. Mr. Williams was admitted to Marconi House School for wireless training, where he gained the P.M.G. Certificate, and was appointed to the seagoing staff of the Marconi Company last May.

MR. ROBERT HAWKER NASH was born at Barton-upon-Irwell on October 13th, 1893. He was educated at Hulme Grammar School, and trained at the Manchester Wireless Telegraph Training College, where he qualified for the P.M.G. Certificate. He was placed on the operating staff of the Marconi Company in January, 1913. Mr. Nash sailed on numerous ships in the course of his duty, and did good service when on board one of H.M. transports which was sunk by torpedo in 1917.

Uig, Ross-shire, was the birthplace of MR. NORMAN MACIVER twenty-one years ago. After receiving his education at Bernera, Stornoway, he assisted his father, a master fisherman, and when not at sea worked on his father's croft. His wireless training was received at the North British Wireless Schools, Glasgow, and, after passing the P.M.G. examination for his certificate, he joined the operating staff of the Marconi Company in June, 1917.

MR. CEDRIC RICHARD MARSHALL, born at Jarrow-on-Tyne on August 4th, 1899, was educated at the Birkenhead Institute, and commenced his career in an African produce broker's office. His wireless training was received at the Liverpool Wireless

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ROLL OF HONOUR.

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Telegraph Training College, and on receipt of the P.M.G. Certificate he proceeded to sea as a Marconi operator in November, 1917.

MR. SYDNEY HARSANT POPPY was born on April 30th, 1901, at South Leyton, and was a pupil at Brentwood High School. After completing the curriculum there, he decided to take up wireless as a career, and was trained in radiotelegraphy at Marconi House School. Mr. Poppy was given the P.M.G. Certificate in April last, and then entered the service of the Marconi Company.

Born at Carrigdangan, Co. Cork, on October 4th, 1894, MR. DANIEL HORGAN was educated at Kilhanna National School, and St. Ignatius College, Galway. He attended the Irish School of Telegraphy, Cork, and there qualified for the P.M.G. Certificate. After its award, Mr. Horgan joined the Marconi Company's service in August, 1916.

Formerly employed in the Town Clerk's office at Bolton, his native place, MR. WILLIAM DOUGLAS CRAWSHAW was born on April 29th, 1901, and educated at Clarence Street Council School, and the Church Institute, in that town. He took a course of training at the Manchester Wireless Telegraph Training College, and received the P.M.G. Certificate. Mr. Crawshaw entered the Marconi service in October, 1917.

Also a Lancashire lad, MR. HAROLD WHITTAKER was born at Royton on January 28th, 1900, and received his schooling at Hulme Grammar School and Elmfield College, York. He was employed for a time as clerk in the office of a cotton spinning company, after which he became a student at the City School of Wireless Telegraphy, Manchester. When possessed of the P.M.G. Certificate Mr. Whittaker was placed on the seagoing staff of the Marconi Company last July.

MR. JAMES FALCONER MCARTHUR was born at Crowhall, Elginshire, on September 28th, 1899, and attended Cullen Higher Grade School and Fordyce Academy for his education. His training in radiotelegraphy was received at the North British Wireless Schools, Edinburgh, and on gaining the P.M.G. Certificate Mr. McArthur was placed on the operating staff of the Marconi Company in January of this year.

Correspondence

An Interesting Optical Illusion

THE following letter drawing attention to a remarkable phenomenon in connection with the *Wireless Press* Armature Model will, we are sure, be read with interest by the many purchasers of that useful production :

THE EDITOR,

" Dear Sir,—May I be allowed space in your columns to point out an interesting " optical illusion which can be obtained from the *Wireless Press* armature model ?

" Take either of the circular end sections of the model in the hand, and move " the hand round and round in a horizontal plane. Two white sickle-shaped " brushes will then be seen to rotate over the windings, in the same direction of " rotation as that of your hand.

" I believe this phenomenon is similar to that obtained from a drawing which " can be made for the purpose of producing a circular diffraction grating on a " photographic film. The drawing consists of alternate black and white concentric " rings.

" Hoping this may interest some of your readers,

" Yours, etc.,

" S. L. MAINPRIZE, *Lieut.*"

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Instructional Article

NEW SERIES (No. 7).

EDITORIAL NOTE.—Below we give the seventh of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

ELASTICITY (*continued*).

IN the last Article we said that a moving charge sets up magnetic flux and that in the case of two oppositely charged conductors separated by a strained dielectric the strain in the latter should have disappeared by the time all the potential energy stored in it had assumed the kinetic form. Having now armed ourselves with the idea of the lines which tend to shrink and which repel each other laterally, let us again attack our subject.

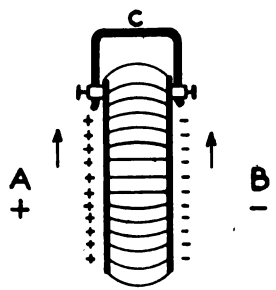

FIG. 29.

Refer to Fig. 29; this represents a condenser which in imagination we are going to discharge. In other words, we are going to make the charge move, or transform the electrostatic energy of the charge into electrokinetic energy, incidentally losing some, because, as was mentioned in the section on Energy, such loss is bound to occur in any energy transformation. When the plates *A* and *B* are joined by the *low resistance* wire *C*, the discharge is oscillatory and continues for a certain time which is determined by the resistance and the radiative property of the circuit. As soon as the plates are connected the energy begins to remove *from the dielectric to the circuit*, and this is equivalent to saying that there is a decrease of stress or a weaker field because the charge on the plates is decreasing; hence there must be a decrease of strain in the dielectric by virtue of its elasticity. Again, whilst the current in the circuit is growing there will be an *upward movement* of the charges on the plates—that is, *upward* in a case such as Fig. 29 depicts, or in general, a movement *towards* the connecting wire.

Now notice that the lines terminate in positive charges on the plate A and in negative charges on the plate *B*, and that as these charges move upward they are accompanied by the lines; one can conceive that they drag the ends of the lines with them. Thus at the end of the first ¼th cycle there exists a state of affairs something like that shown in Fig. 30; the + and − charges are moving towards each other along the wire and the lines are contracting lengthways, some having already disappeared. We can imagine these lines to have become so short that their ends have actually met. The figure also shows that there is a decrease of strain in the dielectric.

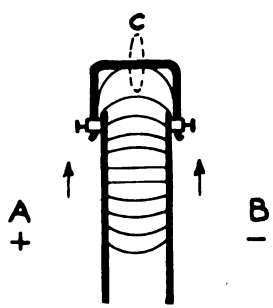

FIG. 30.

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At the end of the first quarter-cycle all the energy is in the circuit, the strain in the dielectric has disappeared, and there is a field of magnetic force set up at right angles to the direction of the motion of the moving charges. (Fig. 31.) At this stage we have I_{max} in the circuit. (See section on Harmonic Motion.) The nature of the discharge being oscillatory there is no interval between the stage just described and the commencement of the recharging of the plates and the consequent return of strain in the dielectric.

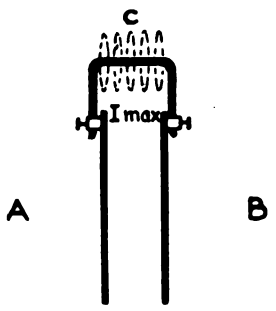

FIG. 31.

The production of electromagnetic waves involves the production of the two components, electric force and magnetic flux, the one diminishing as the other increases, then *vice versa*, and so on in a series, some of the energy originally stored in the dielectric being radiated and constituting together with the heat losses in the circuit the loss due to the transformation of energy. A full discussion of this process belongs to the textbooks of wireless telegraphy and the present article is intended to prepare the reader for further study of the subject by rendering him more familiar with the terms, often unexplained, which he may meet in such books.

ATOMS AND MOLECULES.

In regard to what follows concerning the constitution of matter it should be understood that we are dealing with this subject more from the standpoint of chemistry than from that of the latest conclusions of physics. Hence the fact that atoms are subdivided into "positive ions" and "electrons" has been ignored. Generally speaking, science at present owes far less to the electron theory than to the atomic theory on which it may be said the foundations of modern chemistry are laid. In these elementary articles we refer to the atom as a whole and the fact that it is no longer considered to be homogeneous will not conflict with such a treatment. When we say that a molecule of a certain substance is composed of a certain number of atoms, so many of one kind and so many of another, or when we speak of the weight of an atom or of its affinity for another, we are on safe ground. The atom is still the CHEMICAL *unit of matter, and if its name—which implies that it is indivisible—is now inapplicable it ought to be changed, though it is not worth while to do so until its retention is generally recognised as a serious imperfection of scientific nomenclature. When such a purifying process is undertaken there will be found greater causes of offence than the word atom as now applied. If an atom loses an electron it does not cease to be the chemical unit of matter even though it is then renamed a "positive ion"—another name for a positively charged atom—that is, an originally neutral atom which has lost an unit of negative electricity.*

Dalton's atomic theory satisfies the essential requirement of being in accordance with facts, but it was never represented as an ULTIMATE *doctrine.*

The problem of the structure of matter was solved for the time being by the conception and definition of atoms and molecules based on data derived from numerous experiments. The philosophical question as to whether matter is *infinitely* divisible served no practical purpose and science groped to discover whether it possesses some structural unit which may be regarded as bearing a relation to matter in bulk similar to that of a brick to a house—a more useful line of enquiry, because once a limit (even a theoretical limit) to the divisibility of matter is arrived at the ultimate particle is not only partially defined but serves as a definite starting-point for a system of physics.

It is supposed that all matter is made up of indivisible particles so small as to be quite undetectable by the most powerful microscope. Their shape is unknown and their size has been only approximately computed, but their relative weights, taking the oxygen particle as 16, have been determined with great accuracy. Some seventy-eight different kinds of these particles are known to exist and matter wholly composed of any one of these kinds is called an elementary substance or **element.**

These fundamental particles or atoms are not capable of separate existence. They have a perpetual tendency to form aggregations and even when combined will

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readily abandon one group for another. This interchange of atoms is **chemical action** and may be brought about by the mere contact of two substances or by heat, light, mechanical pressure, or electricity. The force which unites atoms is called **chemical attraction** and is believed to be electrical in nature.

A group of atoms held together by chemical attraction is termed a **molecule.** If the atoms are all of the same kind the group is an **elementary molecule**—e.g., a molecule of iron—and the substance itself, that is, an aggregation of such molecules, is an element. If there are two or more kinds of atoms present in the group this is known as a **compound molecule**—e.g., a molecule of water—and the substance is a compound.

(1) *An atom is the smallest particle of matter which can take part in a chemical change. It is indivisible and cannot exist separately.*

(2) *A molecule is a group of atoms forming the smallest particle of matter which can exist separately. It is not divisible by mechanical means but can be split up by chemical or electro-chemical means.*

As an apparent contradiction of what has been stated with regard to the plurality of atoms in the molecule it must be pointed out that there are certain substances—sodium and potassium, for example—the molecules of which are considered to consist of but a *single* atom. Clearly in the case of monatomic elementary molecules we must accept a merging of definitions (1) and (2) and look upon an atom of, say, sodium as being also a molecule of sodium. Such a molecule is, of course, indivisible, but were it possible to split it up we should find that in conformity with the behaviour of all other molecules similarly treated it would lose its original properties, for *in matter of any kind the molecule is the smallest particle in which the original properties of that matter are inherent.* Yet even these unusually independent atoms possess the fundamental tendency to combine and are very chemically active, readily forming a large number of compounds.

Chemical and Physical Changes.—Any change which does not destroy the original properties of a molecule is only a physical change, but if the original atomic structure is destroyed or even altered the change is both chemical and physical. Water can be changed to a solid by freezing it or to the invisible form of steam, but in each of its states, solid, liquid, and gaseous, its component molecules are physically alike and contain three atoms, so that a change from one state to another is purely physical; but if water is electrolysed its molecules are broken up and new molecules of hydrogen and of oxygen are formed, physically and chemically different from the original aqueous molecules.

Molecular Motion.—Molecules are never at rest. They are ceaselessly engaged in darting about at high velocities, colliding with each other and rebounding. Between any one collision and the next the molecule pursues a perfectly straight path, and although its *track* would, therefore, be "zigzag" it may in some cases have a more or less definite direction if considered as a whole during a given period. One difference between solids, liquids, and gases is that in any one of these forms the molecules have a *mean free path* different in length to that of those in the other two forms. This means, for instance, that in solids generally a molecule cannot move so far in a straight line without colliding with another as can a molecule of a liquid. Similarly the molecules of a gas at normal pressure have a greater mean free path than those of a liquid.

The kinetic energy of a molecule of a gas is heat energy and can be expressed by the equation $E = \frac{MV^2}{2}$. From this it can be seen that the smaller the *mass* of the molecule (or the smaller the weight of its atom) the greater is the molecular velocity, V, at a given temperature. If the temperature of the gas is raised the molecular energy and the molecular velocity increase, since the mass remains constant. Hence if we raise the temperature of a substance we impart to its

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molecules a tendency to acquire a greater mean free path, so that in the case of solids and liquids there is expansion in bulk and in the case of a gas enclosed in a vessel there is an increase in the pressure exerted by the gas on the walls of its container. From the above-mentioned equation it follows also that E can only be zero when V is zero, which means that there is a limit below which a substance cannot be cooled because only when a molecule attains absolute rest—i.e., zero V—can it be absolutely cold—i.e., zero E. But we know that a molecule never ceases to move.

Taking into account the collisions of the molecules of a gas not only with each other but with the walls of the vessel enclosing it, it should be clear that at a given moment the molecules will be moving at *various* velocities because the direction and sense of their velocities is constantly altering. Yet at a given temperature there is a *mean velocity* of

$$485\sqrt{\frac{t}{273\,\rho}} \text{ metres per second.*}$$

t being the absolute temperature (in degrees Centigrade) of the gas and ρ the specific gravity of the gas compared with air.

This velocity is the square root of the arithmetical mean of the various values of v^2; the arithmetical mean of these velocities (v) is given by

$$447\sqrt{\frac{t}{273\,\rho}} \text{ metres per second.}$$

Thus in air at normal temperature and pressure the mean velocity of a molecule of oxygen is roughly a third of a mile per second, and the length of its mean free path is of the order of 7·6 hundred-millionths of a metre ($7{\cdot}6 \times 10^{-8}$ metre).

If we reduce the molecular velocity of a gas it will first assume the liquid form and, finally, if the process continues, will become solid. Actually what is done is the reduction of the kinetic energy of the gas by lowering its temperature and subjecting it to great pressure; this reduces the velocity, because v^2 varies as t, and the mean free path becomes smaller. All this amounts to saying that as the intermolecular spaces are reduced the gas becomes denser and tends to assume eventually the general properties of a liquid and finally those of a solid.

Molecular Magnets.—With further reference to the kinetic energy of molecules it is worthy of note that when iron is rapidly magnetised and demagnetised it becomes hotter. According to the molecular theory of magnetisation iron subjected to such an alternating process would have its molecules set swinging, first into positions with the N pole of one aligned with the S pole of the next and so on, all of them forming orderly lines in the direction of the magnetising force, and then back again into stable groups forming closed magnetic circuits, that is, into their natural distribution. By virtue of these enforced movements the molecules apparently acquire extra kinetic energy which is added to the original heat energy.

Summarising, we can say that the chemist's view of matter is that it is an aggregation of molecules moving at various velocities, but always in straight paths, the direction of these paths continually changing as the result of molecular collisions and the lengths of the paths varying according to temperature or pressure; that for a given material at a given temperature and pressure these velocities and lengths can be expressed as *means*, and that within the molecule the constituent atoms, grouped by virtue of chemical attraction, are performing movements which may be likened, for lack of a more precise description, to the movements of the members of a solar system with regard to each other.

Mixtures.—With the preceding paragraphs fresh in our minds the difference between a true compound and a mixture is easy to understand. A **compound is**

* Clausius.

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the result of chemical action, new molecules having been formed possessing properties peculiar to themselves and distinct from those of the substances from which the compound is formed.

Example.—SODIUM. *A soft white metal, easily cut with a knife or moulded in the fingers. Will not form crystals.*

CHLORINE. *A heavy, green, poisonous gas.*

CHLORIDE OF SODIUM (*Common salt*). *Molecules composed of one atom of sodium combined with one atom of chlorine. A white solid, pleasant to taste, odourless, an essential article of food. Crystallises in the form of cubes.*

A simple mixture is the result of mechanical action and its ingredients can be separated mechanically; no new molecules are formed and each component retains its original properties.

Example.—GUNPOWDER. *A mechanical mixture of carbon, sulphur, and potassium nitrate. The latter can be easily dissolved by water and from the residue the sulphur can be dissolved out by carbon bisulphide. Thus the three ingredients are mechanically separated.*

Chemical Attraction.—Oxygen, one of the principal components of the gaseous mixture known as air, has a very pronounced "affinity" for many other elements and readily combines with them. The rusting of iron and the tarnishing of copper and many other metals are due to the presence of free atmospheric oxygen. Yet, on the other hand, argon, another constituent of air, is so chemically inert that it will form no compound whatever, so far as is known. Why is this? Why do atoms display such varying degrees of chemical activity, and why do atoms which are active follow a rule of selectivity, combining readily with some kinds of atoms and remaining "cold" towards others? There are no satisfactory answers to these queries. We only know that given due opportunity certain atoms will abandon their connection with other kinds to form new molecules with a third kind. For want of a better word it is said that an atom has various *affinities* for atoms of other elements, meaning that, as between any one kind of atom and the other seventy-seven existing kinds, there are various degrees of chemical attraction.

The stability of a molecule, simple or compound, seems to depend largely upon its internal energy, but without going into the theory of molecular architecture we can draw from the preceding paragraph the conclusion that a molecule is unstable if the attraction between its atoms is very weak. An unstable simple molecule tends to change into a more stable form of the same element and an unstable compound molecule needs but a slight push to cause the decomposition of its atomic system. Under the heading of chemical action more will be said in regard to the stability of elemental forms of matter.

Examples.—STABILITY. *One atom of hydrogen combines with one atom of chlorine, forming the stable compound called hydrochloric acid, the two gases* UNITING, *when mixed,* BY MERE EXPOSURE TO THE SUN.

INSTABILITY. *One atom of nitrogen will combine with three atoms of chlorine, forming a thin oily liquid called nitrogen trichloride.* BY MERE EXPOSURE TO THE SUN *this unstable compound* DECOMPOSES *with explosive violence. Again, iodide of nitrogen, composed of one atom of nitrogen, one atom of hydrogen, and two atoms of iodine,* is so unstable that it will explode under water and in the dry state will explode if falling particles of dust are allowed to touch it.*

In the next Article we shall discuss chemical action, a subject of vast importance, because it embraces the perpetual redistribution of atoms which takes place throughout the entire realm of nature and in most manufacturing processes.

(*To be continued.*)

* This is its composition given by Szuhay and confirmed by Gladstone. According to Gay-Lussac the formula is NI_3.

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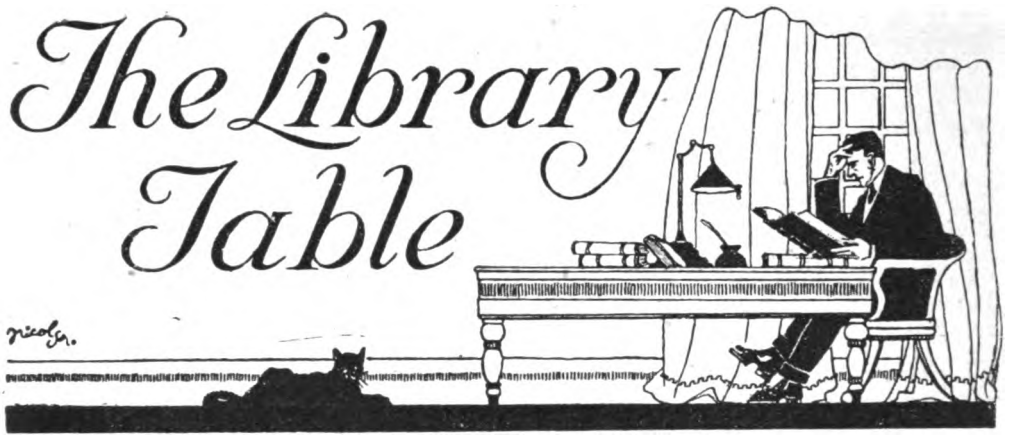

DYNAMO AND MOTOR ATTENDANTS AND THEIR MACHINES. By Frank Broadbent, M.I.E.E. Ninth Edition. London: S. Rentell & Co., Ltd. 3s. 6d. net.

Sufficient evidence of the popularity and utility of this work is contained in the fact that it has now reached its ninth edition. Its aims, as we have indicated when reviewing previous editions, is to provide a collection of practical information for those whose business it is to attend to dynamos and motors in the course of their daily work, and for this reason the theoretical side of the subject, save in the preliminary pages, is scarcely touched upon. Particularly useful chapters are "How to Choose a Dynamo or Motor," "The Erection of Dynamos and Motors," "Faults and Breakdowns in Armatures, Magnets, etc.," and "Faults and Breakdowns in Motors." Wireless men employed on land stations will find much help to them in this handy work.

MANUAL OF WIRELESS TELEGRAPHY AND TELEPHONY FOR NAVAL ELECTRICIANS. By Captain S. S. Robison, U.S.N. London: S. Rentell & Co., Ltd. 8s. 6d. net. Postage 5d.

"Robison's Book" is well known to the more senior wireless operators as one of the first textbooks to deal with the practice of radiotelegraphy in its modern aspect, without recourse to historical disquisitions and a fog of formulæ.

With the rapid advance of radiotelegraphy, several reprints and new editions have appeared, and now we have before us the fourth revised edition, which is fully three times as thick as the original work. This year, owing to Commander Robison's preoccupation in war work, we have the collaboration of Captain D. W. Todd, U.S.N., and Commander S. C. Hooper, U.S.N., both men well known in the radio world, while a number of suggestions have been made by other members of the Wireless Service of the United States Navy.

The new edition follows the same lines as the previous one, but a number of additions are noticed, particularly the inclusion of six pages devoted to the Federal Poulsen systems. Wireless Telephony, however, is still inadequately treated, barely a page being given up to the subject, notwithstanding the title of the volume which certainly leads one to expect more. Thermionic valves, too, are given, less than three pages in spite of their extensive use in the American Navy. If the omission of fuller treatment of these two subjects is due to lack of space, then we would suggest dropping some of the out-of-date matter, which is of historic interest only. Surely we no longer need diagrams of forgotten De Forest, Massie and Stone circuits, particularly when they are labelled as obsolete.

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Perhaps the most interesting feature of the new edition—to the English student at all events—is the description of the U.S. Naval Type " A " receiving set. Those who think that they have nothing to learn in the way of receiving circuits will be surprised at the variations from the normal here shown. Thus, the usual inductive coupling, requiring either rotating or laterally moving coils, is replaced by a condenser coupling for which is claimed a much higher efficiency on long waves. The " standbi " circuit has also points of novelty, and the whole instrument is particularly well explained both with diagrams and photographic illustration.

On the other hand, the Lowenstein diagrams, which really have few points of novelty, are models of how *not* to illustrate wireless circuits.

Analysed and redrawn on conventional lines, they present few points of difficulty, but a certain degree of expertness is required to do this. As it stands, Fig. 105 must be incomprehensible to the student for whom the book is designed. We would suggest some modification of this drawing in subsequent editions. However, in spite of the minor defects above mentioned, the volume remains in the front rank of " wireless " textbooks, and well deserves the wide popularity it has attained.

THE AEROPLANE SPEAKS. By H. Barber, A.F.Ae.S. Sixth and Revised Edition. London: McBride, Nast & Co., Ltd. 6s. 8d. *net.*

Among the many textbooks in aviation now available, this work stands out prominent by reason of its originality of treatment. " The reason impelling me to " write this book," says Captain Barber in his foreword, " is a strong desire to help " the ordinary man to understand the aeroplane and the joys and troubles of its " pilot; and secondly, to produce something of *practical* assistance to the pilot " and his invaluable assistant the rigger." How admirably the author achieves his first aim can only be realised by those who have read the work, while as to his second, the popularity of the book among aircraft workers, and in the air service itself, is sufficiently convincing without any word from us.

The main point of originality in treatment consists in making each part of an aeroplane describe its work and argue with the other parts as to its relative importance. As a result, we get some delightfully humourous touches, which do much to keep our interest alert in those parts of the subject which would otherwise prove " dry." Thus, starting with a brief explanation by a Surface, we come to an argument between the Propeller and Efficiency, and one by one, as the defects become apparent, the other portions of the aeroplane enter into conversation, until, by the end of the part, we have covered the whole ground of the elementary principles. Part 2, entitled " The Principals having settled their Differences finish the Job," is written in the same amusing strain. It is no mean achievement to explain in two chapters the meaning of such terms as thrust, drift, and stability, in their relation to the modern flying machine, and to make clear such points as, why in a modern biplane the two surfaces are staggered in relation to one another; what is meant by the optimum angle of incidence and the dihedral angle. It is safe to say that he must be a dull reader indeed who has not a fair comprehension of these matters by the time he has reached this point. Parts 3 and 4, entitled " The Great Test " and " Cross Country," are particularly brilliant pieces of descriptive writing, in which is described how the machine previously designed was taken out of the aerodrome and flown across country to its destination. These parts serve the double purpose of describing how the machine is controlled in the air and introducing a great deal of flying " slang," which, unless explained, is likely to cause a deal of trouble to those studying aviation.

Particularly informative is the illustration on page 42 showing the pilot's seat, together with the numerous controls and indicating devices which have to be kept constantly under his supervision. The layman who thinks that the pilot has to control merely the " joy stick," and the rudder, and find his way by observation

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and a map, will be surprised to find in the picture an oil gauge, ignition switch, throttle control lever, inclinometer, watch, air safety indicator, altimeter, petrol gauge, and compass, apart from the many devices which are of special war utility, and which, of course, cannot be described in a textbook for general circulation. It is quite permissible to mention, however, that in single seater machines, the pilot has not only to observe all the instruments already mentioned, but also to handle the delicate bomb-dropping mechanism, machine gun, camera and wireless instruments.

Professional flying men will be interested in the discussion on what changes in the design of the average machine most pilots would like. Speaking of the difficulties of landing with a fast machine, the author puts it into the mouth of the pilot to say that "it is all the fault of the tail. There is hardly a type of aeroplane "in existence, in which the tail could not be raised several feet, and that would make "all the difference. A high tail, means a large angle of incidence when the machine "touches ground, and with enough angle, I will guarantee to safely land the "fastest machine in a five acre field." The obvious difficulties in the way of carrying this out are suggested in the argument between the pilot and the observer which then follows.

These three parts complete the prologue, or that portion of the book which is written in the conversational style. Following this come five chapters dealing with the principles of flying on more conventional lines. Here, as in the previous part of the book, the author displays the same lucidity of explanation which is such a valuable feature of the work, the manner of treatment allowing the construction of the machine to be dealt with in far greater detail. Chapter 1 deals with flight, and such matters as chord, drift, head resistance, angle of incidence, camber and aspect ratio; chapter 2 with stability and control, and chapter 3 with rigging. In order to rig an aeroplane intelligently and to maintain it in an efficient and safe condition, it is necessary to possess some knowledge of the stresses the machine is called upon to endure, and the strains likely to appear. All of these are very thoroughly dealt with by Captain Barber both textually and with the aid of diagrams. Finally, we have an excellent glossary, which is followed by a large number of plates illustrating the evolution of the aeroplane.

We understand from the publishers that a seventh edition will be ready very shortly, and with the increasing interest displayed by the public in aviation this should soon be absorbed.

Altogether the book is eminently readable and informative, and can be recommended to those who, with no previous knowledge of the subject, wish to obtain, in the shortest possible time, a sound basis of knowledge on aviation.

Share Market Report

LONDON, *September 11th*, 1918.

The market in the shares of the Marconi group has been very active during the past month, with considerable investment buying of the shares of the Marconi International Marine Communication Company, Limited.

The prices of all the issues show a marked improvement as we go to press. Marconi Ordinary, £4 7s. 6d.; Marconi Preference, £3 12s. 6d.; Marconi International Marine, £3 5s. 9d.; Canadian Marconi, 14s. 6d.; American Marconi, £1 10s. 3d.; Spanish and General, 12s. 3d.

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Personal Notes

A New Post.

The first resident inspector in Montreal to represent the Marconi International Marine Communication Company, Ltd., has recently been appointed in the person of Mr. J. C. Hawkhead, the author of the well-known *Handbook of Technical Instruction for Wireless Telegraphists*, whose photograph, taken whilst holding the position of Director of Posts and Telegraphs, British Somaliland, is reproduced. Mr. Hawkhead has had long and varied experience in wireless. Appointed a learner at the Seaforth School of the Marconi Company in 1906, he was, with the exception of a period of shore duty at Niton station, operating at sea until 1910, when he joined the Madeira Marmoré Railway Company under a year's contract, and was appointed to the high-power wireless station at Mañaos.

Returning to England in 1911, he again took up sea duties, and was serving on board s.s. *Olympic* at the time she was rammed by H.M.S. *Hawke*, and later for a period on the Egyptian State Yacht *Mahroussa*, receiving a gold monogram scarfpin from the ex-Khedive Abbas Hilmi II. in recognition of his services.

From its inception in 1912 Mr. Hawkhead acted as an instructor in the Marconi House School until September, 1913, when he accepted an appointment under the Colonial Office Service as Superintendent of Telegraphs, British Somaliland, and in 1917 Director of Posts and Telegraphs in that territory, which latter he has relinquished for reasons of health, resuming his employment with the Marconi Company in July, 1918. We wish Mr. Hawkhead all success in his new undertaking.

MR. J. C. HAWKHEAD.

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AN AMERICAN HERO.

Misinterpretation of fog signals is believed to have been the cause of the collision between an American coastwise liner and another vessel, off Atlantic City, U.S.A., early in May, causing the loss of 68 lives.

F. J. Doherty, the wireless operator, stuck to his post, sending calls for help. Captain A. G. Forward, commander of the liner, three times ordered Doherty to leave his post and save himself, but the operator refused. He was working the key as the liner sank.

AWARDS.

Twice previously mentioned in dispatches, Major E. J. M. Nash, eldest son of Mr. A. J. Nash, a General Manager of the Royal Mail Steam Packet Company, has recently been awarded the D.S.O., and promoted to be Acting Lieut.-Colonel, for special services in Mesopotamia.

MAJOR B. S. BENNING, R.A.F., of Dunstable, formerly in the service of Marconi's Wireless Telegraph Co., Ltd., on the staff of the Chief Engineer, has been awarded the Croix de Guerre, with palm leaf, for signal service in France.

IN KHAKI.

SAPPER H. J. LEGG, R.E.

The accompanying is a photograph of one of Marconi's Wireless Telegraph Company's staff, SAPPER H. J. LEGG, R.E., now doing duty at an Army wireless station "somewhere in England."

AN INTERESTING WEDDING.

The marriage took place recently at Heckmondwike, Yorkshire, of Miss Olive North and Wireless Operator Percy Hanson, R.N.R., who was formerly a telegraphist at the Post Office.

The bride was one of the passengers who had the good fortune to be rescued from the torpedoed *Lusitania*, and the bridegroom, who joined the R.N.R. shortly after the outbreak of war, has also been lucky in escaping from disaster at sea.

CRICKET.

A cricket match arranged by Mr. L. P. Grice in aid of St. Dunstan's Hostel for Blinded Soldiers was recently played at K.E.S., Five Ways Grounds, Edgbaston, between Marconi Wireless C.C. and Mr. L. P. Grice's XI. The latter side won by 112 to 51.

OBITUARY.

We regret to record the death of WIRELESS OPERATOR F. C. LOCK, Canadian Regiment of Royal Engineers, formerly a telegraphist at the Cardiff Post Office, who was killed in action in France in June last.

Prior to joining the Army he was doing duty as a wireless operator at Vancouver, B.C., where his loss will be deeply felt. Operator Lock was the eldest son of Mr. and Mrs. F. C. Lock, Splott Road, Cardiff, to whom we tender our sympathy in their bereavement.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly.* (3) *Queries should be as clear and concise as possible.* (4) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers.* (5) *The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

T. E. D. (Dublin).—(1) Spark frequency is the frequency at which the *oscillation-trains* occur. For every condenser discharge a group of oscillations takes place, the frequency of the oscillations themselves being purely dependent upon the capacity and inductance of the circuit in which they take place. If we take the case of a circuit adjusted to a frequency of 500,000, and charged from a 50-cycle alternator, then, with a synchronous discharger, the condenser will be charged twice for each cycle, and will give 100 sparks per second. The "spark-frequency" will thus be 100, and the "oscillation frequency" 500,000. You will see that the spark frequency is independent of the capacity and inductance of the circuit, while the oscillation frequency depends on these factors only. (2) Your question is not quite clear. The voltage at the terminals of the secondary of the transformer is dependent upon the ratio of the number of turns in the secondary to those of the primary. Thus, if there are twice the number of turns in the secondary, then there will be twice the voltage, although the current will be approximately halved. (3) Yes, the frequency is the same in both cases. (4) For the reason that you cannot take out of the transformer more energy than you put into it. If the voltage is doubled the current is halved. If the voltage is multiplied by ten, then the current is only one-tenth of that in the primary, and so on. You should study the principles of the transformer in Bangay's *Elementary Principles*.

R. D. (Norwich).—(1) The Post Office wireless stations are operated by men who have been recruited from the Post Office wire telegraph service, and there are no vacancies for men not previously so employed. (2) It is possible, although we cannot in any way forecast post-war conditions, that there might be a vacancy suitable for you in Marconi's Wireless Telegraph Company or the Transocean Wireless Telegraph Company after the war. We are not aware of any vacancies at the present time. The address of both of the above companies is Marconi House. In peace times they operate Poldhu, Clifden, and Carnarvon.

L. S. (Mansfield).—(1) Yes, he must pass the Marconi Company's own doctor before being accepted for employment. (2) At the present moment £1 5s. per week, board and accommodation being provided on board ship. The rates may be revised at any moment, possibly before this page appears in print. (3) Operators in the employ of the Marconi Company are required to sign an agreement to serve for at least twelve months. An operator may be placed in charge of an installation after making but one or two trips, if he shows the necessary ability. He then receives an additional 5s. per week charge money.

"A STUDENT" (Aberdeen).—(1) and (2) Full particulars of "How to Become a Wireless Engineer" were printed in our issue for May last. (3) Conditions vary. Why not apply to the R.A.F. Recruiting Officer, Music Hall, Edinburgh? He will give you full particulars. He will also answer your question. (4) We believe in the affirmative, provided you are found suitable. Thank you for your good wishes.

LEADING TELEGRAPHIST (H.M.S. ——).—(1) As much information as it is permissible

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to publish on this subject appears in the current *Year Book of Wireless Telegraphy and Telephony*. (2) No, the Marconi double-note magnifier, which has been designed to give good magnification with the utmost simplicity and the minimum of adjustment, works by the "cascade" method without recourse to the "reaction" principle. There are, of course, other Marconi receivers working on the reaction principle. We are glad you like our magazine. With regard to further articles on Valves and Continuous Wave work, we hope to publish many others in the near future. We are labouring under certain disadvantages in this connection, seeing that the most interesting developments in valves and continuous wave work are under the ban of secrecy, being used in the Army, Navy, and Air Service.

Y. L. S. (Guildford).—Yes, it is necessary to take into account the inductance of the earth lead in calculating the wave-length of an aerial, for, as you say, it may possess a considerable value in certain cases. For greatest efficiency, the jigger should be as close as possible to the actual earth connection.

G. L. W. (Auchtertool).—(1) No, we do not think so from present appearances. If you wish to study wireless telegraphy with a view to becoming a wireless operator in the Mercantile Marine, it is still open to you to take a course at one of the wireless schools advertised in this magazine. On obtaining the P.M.G. first-class certificate, you can then make application to the Marconi Company to be placed on their waiting list. (2) The wireless training at the Crystal Palace is in connection with the R.N.V.R., particulars of which may be obtained at the nearest Naval Recruiting Office. This also answers your question (3). (4) The training is free, but is given only to enlisted men.

ALPHA (Essex).—The medical standard is, we believe, the same as that for other commissions. In view of the fact that you had four years' O.T.C. training before you took up the study of wireless, we would suggest that you get into communication with the Recruiting Officer, Royal Air Force, Hotel Cecil, London, W.C.2, giving him full particulars of your qualifications and making application for a commission. For the R.E. Wireless Section, you should communicate with Major Handley, R.E., Wireless Training Centre, Worcester. Either branch of the service will give you the other information you require.

"TRANS" (B.E.F., France).—With an "inverted L" aerial, 80 feet high and 600 feet long, there should certainly be a marked directional effect in reception, the best signals being received from the direction opposite to that of the free end. (2) With two such aerials set at right angles, with the earthed ends adjoining, the strength of signals is equal in each, when the line of direction from which the signals come bisects the right angle. Otherwise, that aerial will receive the strongest signals which is nearest in direction to the point from which the signals proceed.

T. G. (Bayswater).—You would be well advised to study wireless telegraphy in your spare time, as, if you obtain a Postmaster-General's 1st Class Certificate, your chances of acceptance are very much higher. We do not anticipate that the Marconi Company will be taking any men other than those who possess a 1st Class Certificate for a long time to come, and we see no prospects of the free training scheme reopening at present. If you obtain such a certificate within a reasonable time, your prospects are good, provided, of course, you are otherwise suitable.

SPECIAL NOTE.

THE MARCONI FREE TRAINING SCHEME IS NOW CLOSED.

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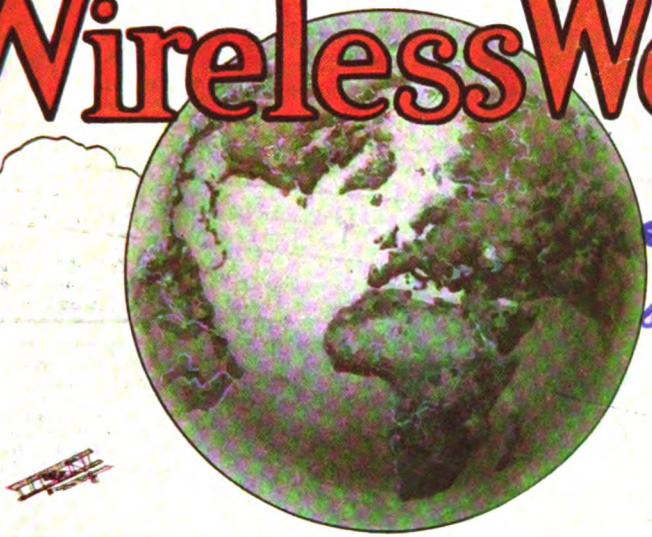

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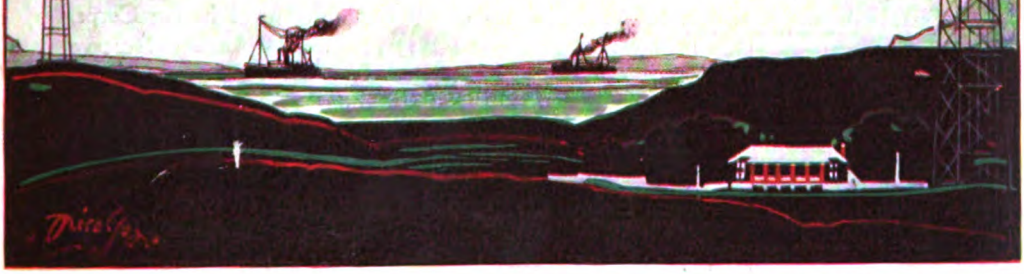

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SUBSCRIPTION RATES.—United Kingdom and British Empire (outside North America), 12s. per annum, post free; United States, Canada, and Newfoundland, $3.00 per annum, post free; and Europe, frs. 15 per annum, post free.

Single copies, 10d. each, or post free 1s. 1d.

Articles submitted for acceptance by the Editor (which will be paid for on publication) should be addressed to Marconi House, Strand, London, W.C. *No responsibility can be taken for MSS. or Photographs sent without stamps to defray cost of return postage.*

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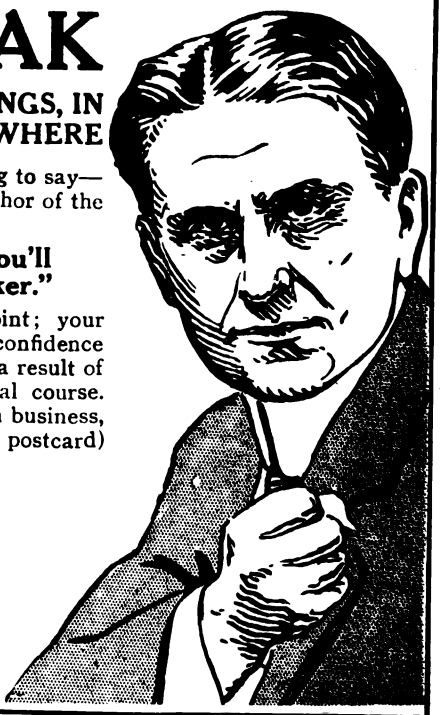

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Without cost or obligation to me, please to send full particulars of Professor Grenville Kleiser's Correspondence Course in Public Speaking and the Development of Mental Power and Personality.—(*W.P.*)

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The
WIRELESS
· WORLD ·

Volume VI. No. 68. NOVEMBER, 1918.

A Labrador Experience

By F. B. RUSHWORTH

In 1906 the Canadian Marconi Company accepted a contract for the working of the Labrador wireless stations on behalf of the Newfoundland Government. These stations, erected primarily in the interests of the fishing industry of Newfoundland, are open only in the short period from June to the middle of October—the fishing season—after which the schooners' crews return to Newfoundland with the salted cod. The catch, day by day, is regularly reported to St. John's, where the market price is thus regulated.

The fish often move from point to point in shoals, and, when located, their movements are advised by wireless to the fishermen, who follow and trap them. Large net traps, costing £160 to £180, are used, the catch being taken from them, loaded into boats, and rowed ashore to the splitting and gutting sheds. Enormous codfish, measuring as much as five feet in length, are frequently caught on this coast.

At that time the wireless installations consisted of the coherer and Morse inker for reception, a fixed jigger, two 10-inch coils, Leyden jars, and a manipulating key for transmission, current being derived from dry cells. Hitherto the service had been far from satisfactory, even for coherer working. This was not so much on account of the ability of those patience-teasing tubes—to collect all the X's possible, and take a fiendish delight in mixing them up with true signals, occasionally releasing a few decipherable Morse characters, to conciliate, as it were, the exasperated human, and urge him to further effort—but because the men who had been sent

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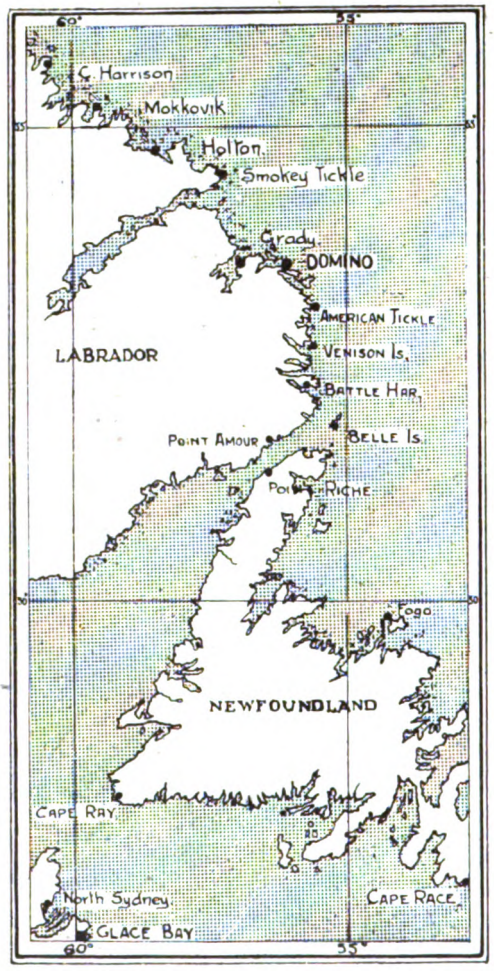

PRESENT-DAY NEWFOUNDLAND AND LABRADOR WIRELESS STATIONS.

previously were without experience in wireless. Recruited direct from the Newfoundland Postal Telegraph Service, they had never operated a Marconi installation before arrival on their several stations. The result may be easily imagined, for to work through all this interference was difficult enough for Marconi-trained men. The contract referred to necessitated the installation of an oil engine, 1 kw. dynamo, switchboard, and 18 two-volt accumulator cells, on the transmitting side; and a magnetic detector to supersede the existing receiving apparatus at Battle Harbour, Domino, and Indian Harbour, the latter station (since removed to Smokey Tickle) then being the most northerly. Venison Island and American Tickle remained as originally installed.

Our party consisted of two engineers, five operators, a carpenter, a rigger and a cook. We left St. John's on board the s.s. *Virginia Lake* in July, and took with us the various pieces of apparatus, station foodstuffs, general stores and coal for the season, not forgetting sand and cement in bags, to be used in the construction of the engine bed. After leaving Battle Harbour, Venison Island and American Tickle were visited in turn, before reaching Domino, or "The Isle of Ponds," with which station this narrative is concerned. Travelling had been necessarily slow on this rugged coast, for each night the ship made harbour and did not proceed until the following dawn. On arrival at Domino, the stores were lowered into fishermen's boats and rowed ashore. A block and tackle having been rigged, they were hauled out, and landed at a point some quarter of a mile from the wireless station.

All this takes but little time to tell. The actual and arduous work took much longer.

The first sight to greet the eye when the mast came into view was a broken topgallant-mast, which, we at once realised, meant considerable additional work. On near inspection it was found that the broken portion, measuring 10 feet, together with the cap and steel stays, was lying on the ground, having apparently been snapped off during a violent winter storm. Everything had to be carried to the station on sling barrows, and the operators forming the working party experienced for the first time the actual weight of such trifles as engines, dynamos and acid carboys, and the dead weight of coal, sand and cement. To their lot also, fell the work of excavating for the engine bed, 6 feet long, 3 feet broad, and 6 feet deep, the collection and breaking up of rock, and the mixing of it with

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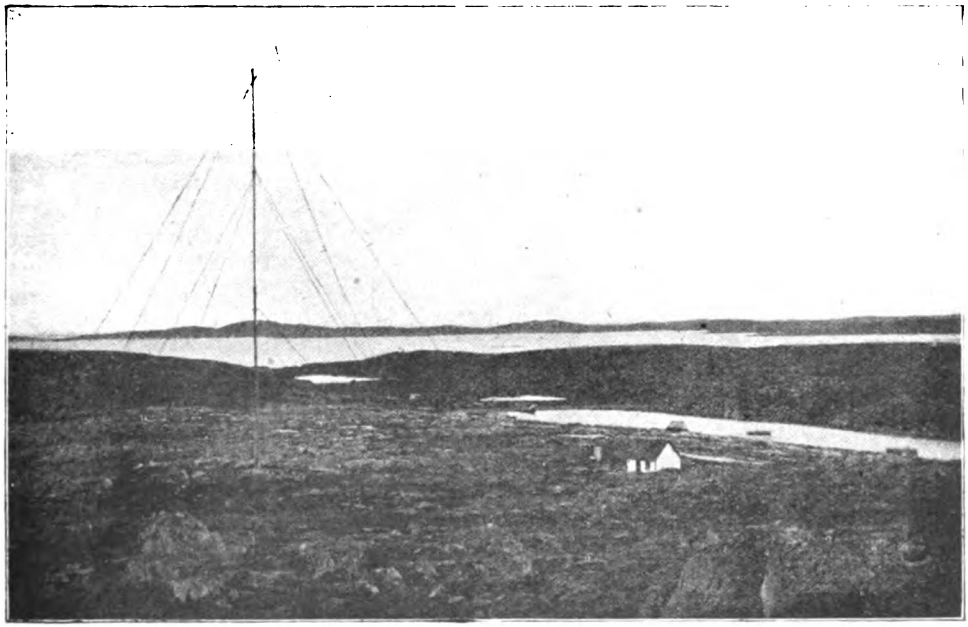
sand and cement for filling in. However, at last the heavy work was done. The broken topgallant-mast was lowered, recapped and raised into position again, with a long sprit added to compensate to some extent for the portion broken off, and the stays shortened and reseized. The engine and dynamo were laid, the switchboard erected, and the cells joined up ready for their long initial charge. Then the trouble started. Lengthy and prolonged search failed to reveal the engine belt. It had not been included. What was to be done? It was time that the chain of wireless stations should be open, but at least a month must elapse before a belt could be received from St. John's. After much thought and suggestion one of the engineers hit on the plan of making a belt from canvas. This was accomplished, as fortunately the fishermen's store contained sufficient for the purpose, a fair substitute for the leather article being fashioned with needle and palm. So far so good. The engine and dynamo ran well, and, although there was much slipping of the belt at first, after many adjustments this was practically eliminated. The cells were now put on for a 30 hour charge. All went like clockwork for an hour or so, when more lubricating oil was requested by the "man on watch," as the oil jacket and cups were running dry. Two of us went outside to bring in the barrel of oil, as we thought, but none could be found, as none had been landed. Here was a real quandary. The absence of the belt had been bad enough, but this was, if possible, worse. Everything on the station in the way of fats that might possibly be used was enumerated, but to no purpose, as we had only vaseline, lard, butter and kerosene. It suddenly occurred to me that when looking round the sheds used for splitting and gutting the fish we had encountered a most disagreeable odour, which, on inquiry, proved to emanate from a large puncheon into which, it transpired, the livers plucked from the split codfish were deposited. There they remained, the action of the sun and air gradually extracting the oil from them. Would not this crude oil serve at a pinch? The suggestion was put forth and eagerly adopted. In a short time two men, armed with a discarded peach can for a ladle and an empty five-gallon paraffin tin, wended their way into the night towards the



DOMINO, LABRADOR: WIRELESS STATION AND MAST.

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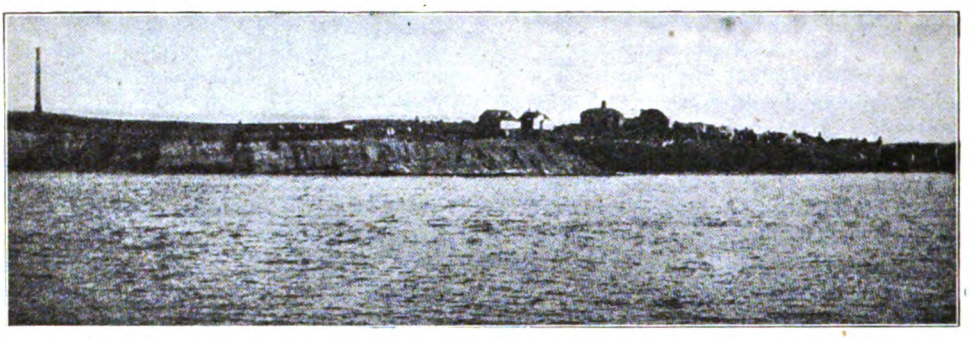
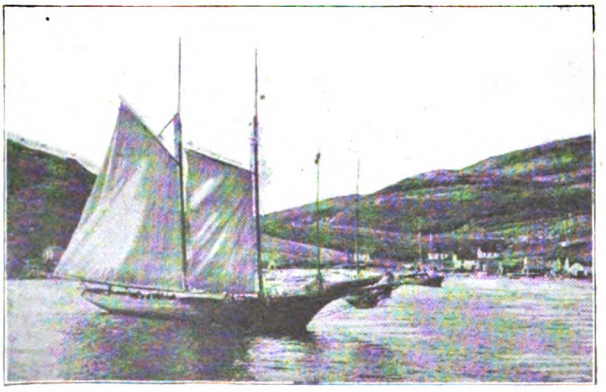


INDIAN HARBOUR, LABRADOR. THE WIRELESS MAST IS SEEN ON THE LEFT.

puncheon. No light was needed to guide their feet as they neared the place. The scent was quite sufficient. Anyone fond of cod liver oil would have enjoyed a banquet, but these two returned to the station, carrying the crude oil between them, looking as if they had been suffering from sea-sickness for several days. The situation was saved, and the engine lubricated with this substitute until the arrival of a supply of engine oil. I dare wager that the perfume of that same crude oil lingers on the station to this day. The completion of the charging of the accumulators saw the end of the constructional work at Domino, and shortly after I was left alone in charge there. Until operating duties commenced, my time was employed in the domestic duties of cooking, baking, and washing. The supply of provisions was both generous and varied and of the best quality, so that after a few attempts some most appetising dishes were concocted, and I was able to make good bread and pastry. The station contained four rooms: operating room, engine room, kitchen and bedroom, with a loft over all in which the accumulators were placed.

Three watches were maintained, commencing at 7 a.m., noon, and 7 p.m. respectively. Traffic was received at these times from the south, for Domino and Indian Harbour, the replies to the messages being waited for and transmitted before the watch terminated.

In September of the year mentioned a terrific storm, accompanied by a 100-mile-an-hour wind swept the coast. Fourteen fishing schooners were driven into the "Run" at Domino, eleven on the east end of Belle Isle, and ten into Indian Tickle, all more or less disabled. Their crews were in a pitiable condition, and in many cases the dried salted fish on board, representing the labour of many weeks, was damaged by sea water.



A COD FISHERY SCHOONER.

It was imperative that assistance should be obtained for these victims of the storm, as they could be neither housed nor fed. A statement of their distress, together with an appeal for help, was embodied in a message to the Minister of Marine and Fisheries, St. John's, but hours of calling failed to bring response from American Tickle, the next link south of Domino. It was afterwards learnt that the aerial wire at that station

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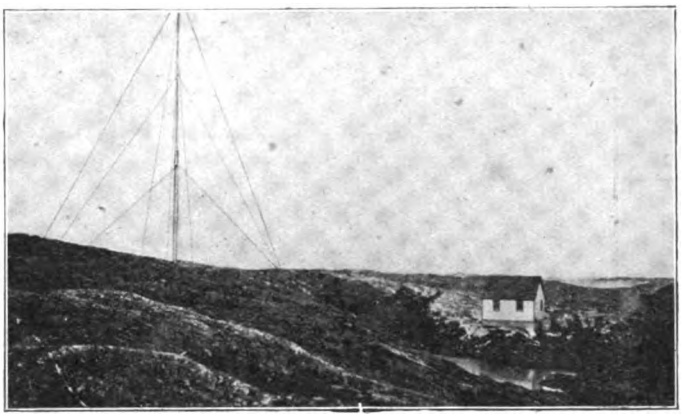
had been completely carried away by the gale. As night fell I could hear Battle Harbour and Belle Isle working, but was unable to interfere. Eventually, by coupling the coils and working plain aerial direct from the dynamo, I had the satisfaction of hearing Battle Harbour complain to Belle Isle of Domino jamming him, upon which I redoubled my efforts, with the result that Battle Harbour took all my traffic. The s.s. *Portia*, deviated from one of her regular ports of call in Newfoundland, by instructions from her owners at the urgent request of the Minister of Marine and Fisheries, arrived forty-eight hours later and took off the shipwrecked crews.



WIRELESS STATION AT AMERICAN TICKLE.

The natives of the islands forming part of the Labrador are called "Livyers," a corruption of "Live here," and are of mixed races. The sole permanent inhabitants of Domino were a family named Watson, and their huskies, or Labrador dogs.

Watson was born of an Esquimo mother, his wife was an Indian, and they had a family of three children.

"Barren" rightly describes this part of the world, for there is nothing but rock and swampy ground. Trees are conspicuous by their absence. The station was closed down and dismantled for the season, towards the end of October, about a week after the departure of the Newfoundlanders.

During the period of waiting for the s.s. *Virginia Lake*, to take passage south, the sky was eagerly scanned each day for smoke on the horizon, the appearance of which would be a warning to me to put up the storm windows and complete packing my effects. I was greatly disappointed one morning. Smoke was observed, and all preparations made in anticipation of embarkation. But the ship sailed by, leaving me in doubt of being marooned. A few days later, however, the vessel I was awaiting arrived, and carried me away from Domino. Upon arrival at Battle Harbour, *en route* to St. John's, I saw and went aboard the ship previously referred to. She was the s.s. *Roosevelt* returning from her search for the North Pole.

A TYPICAL LABRADOR DOG TEAM.

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PERSONALITIES IN THE WIRELESS WORLD

MR. ERNEST SINS. [Photo. Elliott & Fry.

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THE province of Alsace was French in nationality (as it has at all times been in sympathy) at the time when Mr. Ernest Sins was born in 1859. He received his early education at the Lycée of Besançon, an historic city on the River Doubs, in the Department of that name. Thence, in 1879, he was transferred to the great French training organisation known as the Ecole Polytechnique, and he started his career by becoming enrolled in the Corps of Telegraphic Engineers. His employment in that celebrated service was initiated by participation in the establishment and organisation of telegraphic and telephonic systems in Tunisia. On returning to his Mother Country in 1892 he received an appointment in the Central Office of Posts and Telegraphs at Paris, being attached to the department concerned with the construction of telegraph lines. Here he ultimately rose to the post of Telegraph Engineer-in-Chief. During 1899 Mr. Sins became Chief of the Correspondence Department of International Telegraphy. In this capacity he found special exercise for his activities in the field of wireless telegraphy, which at that time was beginning to play a practical part in the world's communications. This post, therefore, placed Mr. Sins in an important position with regard to the development of the new science. In 1903, and again in 1906 ,he attended, as French representative, the International Conferences concerning radio-telegraphy, both of which were held at Berlin. He acted as Secretary to the Commission appointed by the latter Conference for the purpose of drawing up specific regulations. This Commission formulated the first International Radiotelegraphic Convention, and thus has to its credit a most important piece of pioneer work, which has formed the basis of the current International Regulations accepted by all nations utilising radio-telegraphy. In 1911 Mr. Sins, who had just been appointed Sub-Director of the French Telegraphic Department, resigned from the public service in order to be at liberty to play a part in the development of wireless industry. On the establishment of the Compagnie Générale Radiotélégraphique he shared in its inauguration, acting in the capacity of Director, and afterwards accepted the post of Managing Director to the Compagnie Universelle de Télégraphie et de Téléphonie Sans Fil. Since the beginning of 1918 he has acted as General Manager of the Compagnie Générale de Télégraphie Sans Fil.

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Some Aspects of Radio Telephony in Japan

By EITARO YOKOYAMA

(Engineer of the Ministry of Communication, Tokio, Japan)

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Outline of the Evolution of Radio Telephony in Japan

The investigation of radio telegraphy in Japan has been carried on for some twenty years, since the year following the basic invention of Marconi. Great advances both in theory and practice have been made. However, systematic research in radio telephony was not begun until 1906 at the Electrotechnical Laboratory of the Ministry of Communications, under the direction of Professor Dr. Osuke Asano, ex-Director of the Laboratory. Under his direction, and more lately under the direction of Dr. Morisaburo Tonegawa, present Director, Dr. Wichi Torikata, Chief of the Radio Section, and his staff have devoted themselves to exhaustive researches continuing up to the present.

The primary object of the investigations carried on in the Laboratory at first was to obtain steady continuous electrical oscillations by any simple means, and various detailed researches were initiated. Nearly all the devices already described in publications (including the Poulsen arc and the Lepel and new Telefunken gaps) were tried; but they led to no useful results in the Laboratory and had no practical success. Good articulation was not obtained, nor that simplicity and compactness of the apparatus which are of vital importance in devices intended for public use. The mercury vapour gap and revolving gaps of special design were also tried, but in vain. In 1912, after the lapse of six years, the staff of the Laboratory finally devised a new and special kind of oscillation gap which turned out to be excellent for the purpose, and was, therefore, patented in Japan and several other countries. The title "T-Y-K" was given to the system of radio telephony involving the use of these special oscillation gaps as its main feature, the initials of the three inventors' names being thereby represented.* The system has been of practical utility in Japan.

Research in radio telephony is still being continued in the Laboratory in the search for perfection. There was recently invented a kind of rarefied gas discharger, which was developed through the co-operation of Mr. Noboru Marumo and the writer. This will be described at some length below.

Meanwhile Mr. Tsunetaro Kujirai, Assistant-Professor in the Engineering College, Tokio Imperial University, made some valuable contributions to the field. He developed a kind of arc generator in 1910, and a static frequency transformer in 1915, both of which are suitable for radio telephonic purpose, and, therefore, were patented in Japan. These devices will also be considered below.

In addition to the above-mentioned gentlemen, Mr. Hidetsugu Yagi, Professor in the College of Engineering, Tohoku Imperial University, Sendai, Mr. Mitsuru Sayeki, Radio Engineer of the Ministry of Communications, and other radio engineers in the Japanese Navy and Army have also rendered much service in furthering progress of the work.

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* The inventors being Messrs. Wichi Torikata, Eitaro Yokoyama, and Masajiro Kitamura.

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"T-Y-K" System of Radio Telephony.

This is a spark system of radio telephony, and intended especially for short distance communication service, the essential features being compactness, simplicity, and cheapness of the apparatus.

The utility of this radiophone system has been sufficiently proved by its practical employment on both land and sea. The system is now in daily commercial use at the three land stations in the Bay of Ise, which is located in the central portion of the coast of Japan. Though the distance between the farthest two of the above stations is merely eight miles (13 km.), experimental communication was established over a distance of more than 70 miles (110 km.) between shore and ship.

A wall-set type of the apparatus is shown in Fig. 1. It was evolved by the joint effort of Messrs. W. Torikata, Masajiro Kitamura and the writer, and is now used in Japan.

Many publications have already been made relative to the system; certain features of this and a further description will not be necessary in this paper.

A Rarefied Gas Discharger—Evolution of the Discharger.

The investigation was begun with a glass bulb discharger containing rarefied air as shown in Fig. 2, which was inserted in the position of discharger in an ordinary oscillation producing circuit as shown in Fig. 3. In Fig. 2 the glass bulb was of spherical form with a diameter of about 10 cm. (4 inches), and the electrodes made of copper, flat cylindrical in shape, 12 mm. (0·3 inch) in diameter, facing each other with a clearance as small as a fraction of a millimetre. In Fig. 3 G is a direct current generator of 500 volts, R a resister, L an inductance, A a millimetre, V a static voltmeter, D a rarefied air discharger, C_1 a condenser in the primary oscillatory circuit, C_2 the same in the secondary, T an oscillation transformer and H an ammeter for

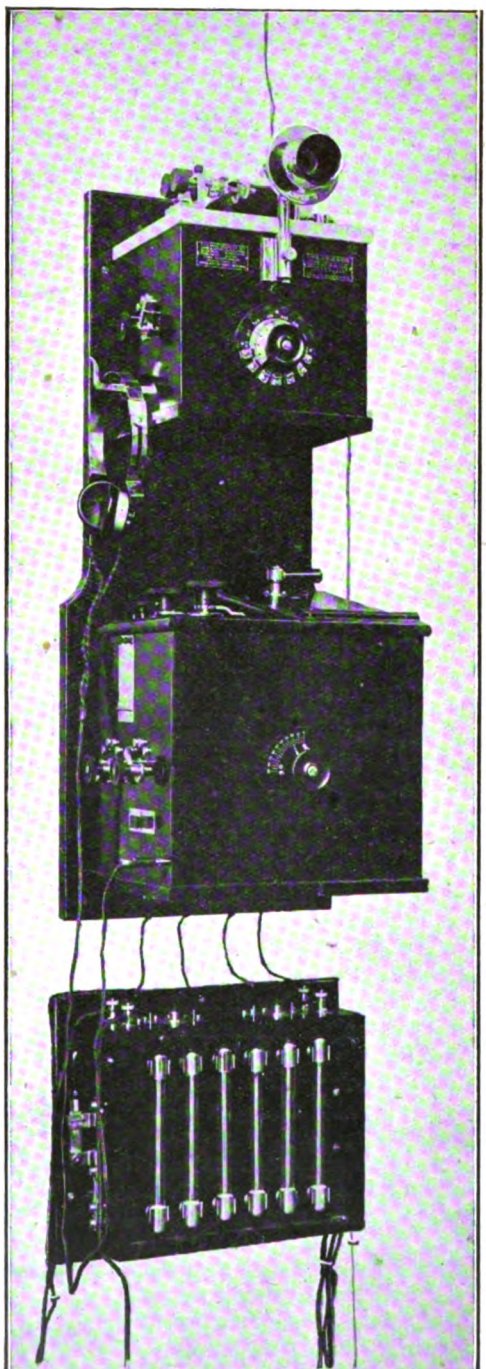

FIG. 1.—A WALL-SET TYPE OF "T-Y-K" RADIO TELEPHONE APPARATUS.

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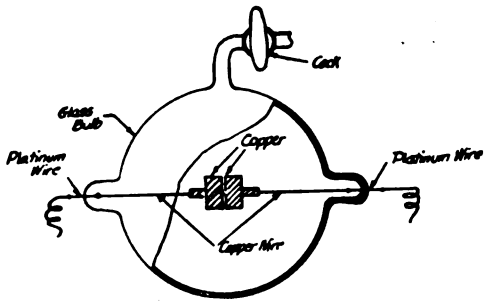

FIG. 2.—FIRST FORM OF RAREFIED AIR DISCHARGER

radio frequency current. When the system was in adjustment and the degree of rarefaction of the bulb properly adjusted, the generation of oscillation current in the secondary was indicated by the deflection of ammeter *H*; but it was noticed that there was objectionable irregularity in the discharge through the gap and consequently in the oscillation current in the secondary, and, furthermore, the oscillations died out after a couple of seconds. When the test was repeated with an aluminium electrode in place of one of the copper ones, the other parts of the bulb remaining the same, it was found that the discharge was not only very steady but also that the oscillations lasted much longer. As the discharge was smoother than any obtained previously in a usual spark transmitter, the research was pressed in many details for the purpose of utilizing the new discharger as a source for radio telephone transmission or radio frequency measurements.

It was, however, noticed that the oscillations would not last more than a few minutes with a bulb of the above construction. In the test a copper electrode was used as anode and aluminium as cathode. If the polarity were changed, it could be seen distinctly that the discharge became irregular and the oscillations faded away very quickly.

It was found that when the discharge was continued until the oscillations in the secondary died away entirely and the bulb was then allowed to cool for some time (the power source being disconnected), and then the oscillations were started again, strong oscillations took place in the secondary as steadily and of the same power as the first time. This led the investigators to the theory that the temperature rise in the electrodes might play an important part in causing the decay of oscillating current. Another bulb with large metallic stems attached to the electrodes was then made as shown in Fig. 4. Besides this the bulb was so constructed that the electrodes could be easily replaced, which enabled the investigators to make tests with several different forms and materials of electrodes. In tests with this bulb connected in the circuit of Fig. 3 there were obtained not merely a steady discharge in the gap and smooth oscillations in the secondary but also a remarkable increase in the duration of the oscillations; for example, as much as thirty or forty minutes. After further investigations dealing with the construction of the bulb and the shape of the electrodes, the investigators developed a rarefied air tube of the form shown in Fig. 5, with which they succeeded in producing exceedingly steady currents in the secondary for hours continuously.

The tube of Fig. 5 is suitable only for small powers; for example, for 100 watts. There was, therefore, developed another form of discharge suitable for fairly large power, which latter form is shown in Fig. 6. The latter has a thick-walled metallic case in place of the glass bulb in the former, the interior construction remaining almost the same.

The dischargers, as finally constructed, were used in a radio telephone transmitter

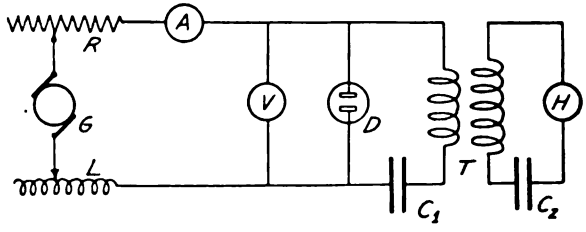

FIG. 3.—OSCILLATION PRODUCER WITH RAREFIED AIR DISCHARGER.

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circuit which was the same as the circuit of Fig. 3 except that the secondary closed circuit was replaced by a real antenna, and a very steady and pure wave, suitable for radiophone use, was obtained in the antenna circuit with a very close coupling such as about 60 per cent. in the oscillation transformer. This indicated a good quenching action in the discharger.

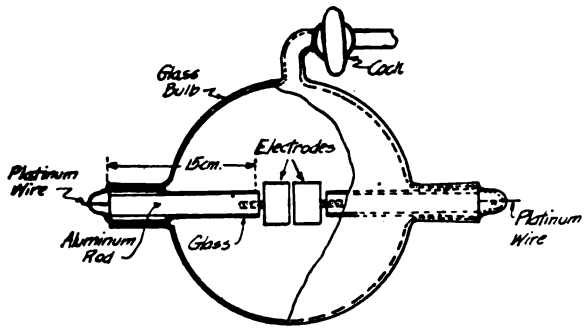

FIG. 4.—SECOND FORM OF RAREFIED AIR DISCHARGER.

The above descriptions apply to a discharger having an atmosphere of rarefied air, but the kind of atmosphere used has a perceptible influence on its operation and life. For instance, the experiments indicated that ammonia gas was very effective, carbonic acid gas fairly good, while alcohol, ether, and benzene in the state of vapour were all useless.

It is very interesting to note that Professor R. A. Fessenden* and Professor Max Wien † made similar investigations with vacuum dischargers.

Arrangements for the Tests.

The writer desires to describe briefly the results of the tests dealing with the influence of air pressure in the discharger, length of the discharge gap, dimensions, shape and materials of the electrodes, and supply voltage to discharger, and the effect of these on its life. Throughout all the tests there was almost always used the arrangement shown in Fig. 3.

To exhaust the dischargers a Gaede rotary pump was used as shown in Fig. 7, which pump is claimed to reduce 6 litres of air from atmospheric pressure to 0·006 mm. of mercury in 15 minutes. For a vacuum gauge a manometer was used as shown in Fig. 8 which enabled measuring roughly any pressure between a little below 1 mm. and 220 mm. of mercury.

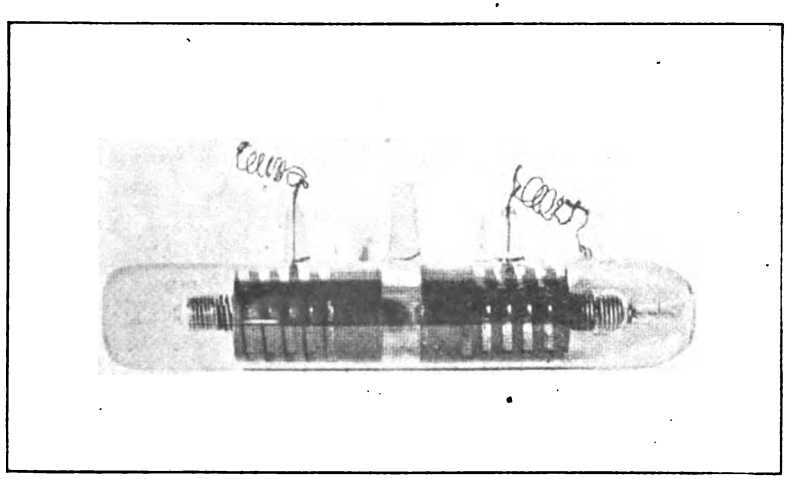

FIG. 5.— LATEST FORM OF RAREFIED AIR DISCHARGER FOR SMALL POWER.

In the tests the wave length was adjusted at about 2,000 metres throughout, with a condenser of capacity of about 0·065 microfarad in the primary

* United Kingdom Patent, No. 28,647. 1907.

† *Jahr. der drahl Telegraphie und Telephonie*, Vol. iv., p. 135.

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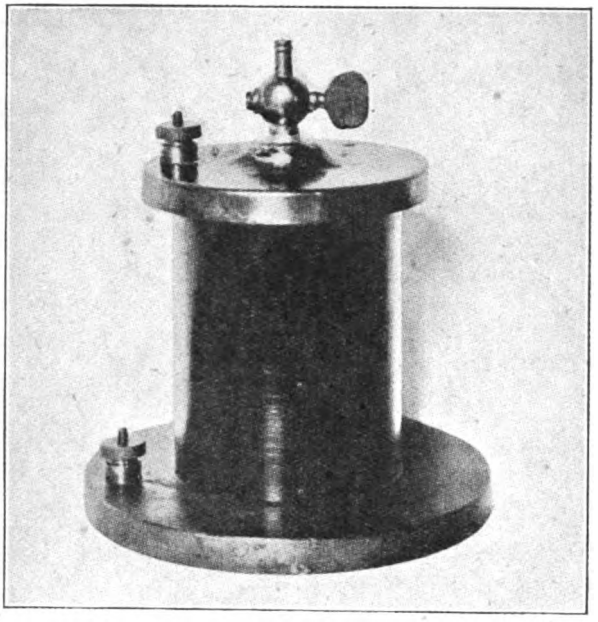

FIG. 6.—A FORM OF RAREFIED AIR DISCHARGER FOR LARGER POWERS.

and about 0·02 microfarad in the secondary. As a final test, however, the result was confirmed with a circuit of some 500 metres wave length, using a condenser of rather small capacity in the primary and a real antenna in the secondary.

INFLUENCE OF AIR PRESSURE ON THE DISCHARGE.

The discharge conditions in the rarefied air discharger largely depend on the air pressure. A change in the type of discharge was observed with variation of pressure. Copper was used as the positive electrode of the discharger and aluminium as the negative, the clearance between being about half a millimetre (0·02 inch). At the centre of discharge surface of the latter a pin-hole was bored, which made the discharge steadier. The voltage of the direct current power source was kept at nearly 440 through the test.

The observations under these conditions are summarized as follows :—

(1) On reducing the air pressure gradually, beginning with ordinary atmospheric

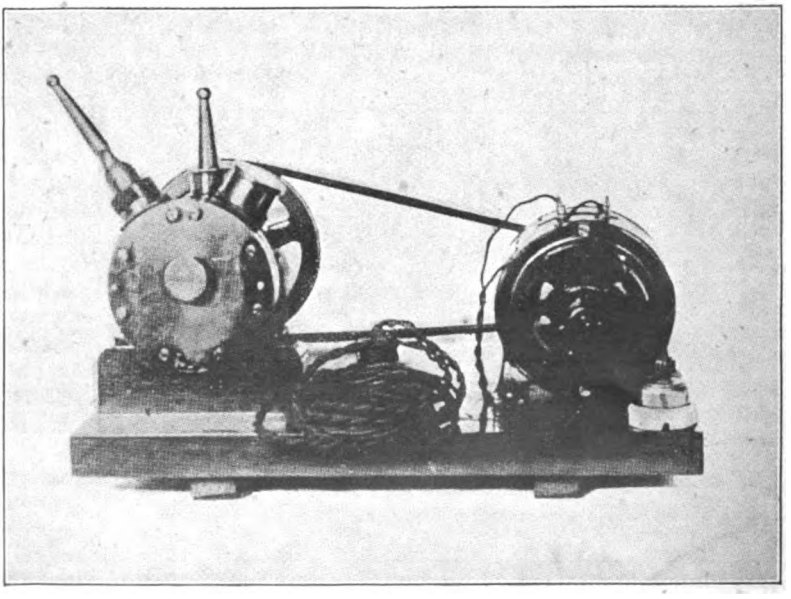

FIG. 7.—GAEDE ROTARY PUMP USED IN THE TESTS.

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pressure, it was noticed that the discharge suddenly bridged over between the electrode surfaces at a pressure somewhere near 70 mm. of mercury.

(2) Within the range from about 70 mm. down to about 40 mm. there will be quiet discharge in a straight line between the centres of the electrode surfaces. The discharge is not very steady, though the oscillations produced thereby in the secondary are apparently quite smooth.

(3) On further reducing the pressure to below 40 mm. the discharge comes to have an entirely different appearance. The discharge, which before was in the form of a single straight line, splits into many lines terminating over the whole surfaces of the electrodes like a brush, while sometimes it changes into the form of a glow discharge, these changes depending on the conditions in the oscillation circuit. In this case the terminal voltage at the gap has its smallest value, and the oscillations in the secondary are very weak and irregular.

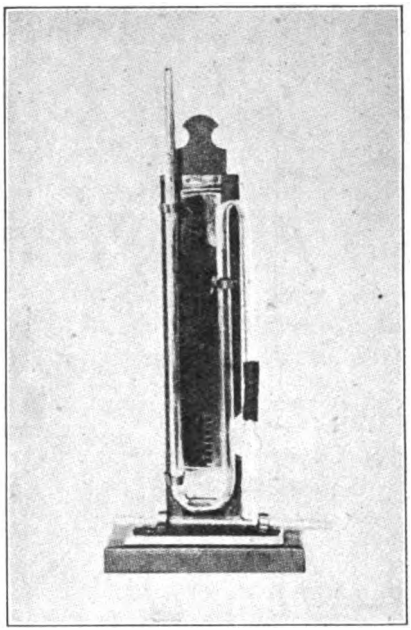

FIG. 8.—VACUUM GAUGE USED IN THE TESTS.

(4) At pressures between about 10 mm. and 2 mm. the discharge is again gathered into a single straight line, just as in case (2). In this case the discharge is, however, remarkably steadier and accordingly the oscillations are also steadier and smoother.

(5) Below the above limit of pressure the discharge tends to change into a diffused glow, and the oscillations rapidly die away.

It was noticed that good oscillations are produced only when the discharge is in stages (2) and (4), and that stage (4) is especially excellent for utilization as a power source in radio telephony.

(To be continued.)

"Sea, Land and Air"

THE August issue of this Australian magazine recently came to hand, and we are glad to note the progress made since its inauguration two months ago. The contents of the present issue include a number of interesting items, amongst which we note a particularly timely article, specially contributed to the magazine by Major C. W. C. Marr, dealing with the "Anzac Wireless Men in Mesopotamia." The writer, who is in command of the Anzac Wireless Squadron in that part of the globe, has a fine two years' record to deal with and makes the best use of his opportunity. The following comment on local conditions for radio work is worth noting here:

"Mesopotamia is a wonderful country for wireless working, and stations that "have a normal range of fifty miles can be worked over distances up to three hundred "miles. Of course, as they get near the hills of Persia the distance covered decreases "a good deal."

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Digest of Wireless Literature

National Physical Laboratory Report.

The report of the Laboratory for 1917-18 has been issued; it is now published by H.M. Stationery Office in consequence of the transfer of the Institution to the Department for Scientific and Industrial Research.

The report of the *Electricity Division*, Section A, of the Physics Department (Mr. F. E. Smith and Mr. Napier) states that most of the time of the Division has been occupied with work of a confidential nature, partly wireless telegraphy. The Laboratory standards of E.M.F. have been compared with those of Japan through the intermediary of some Weston cells brought to Teddington by Dr. Yokoyama: there was a mean difference of four parts in a million, a very gratifying result. Magnetograph records have shown coincidences between the running of electric trains on the L. and S.W. Railway system and magnetic disturbances at the Laboratory, and incidentally have demonstrated the excellent aperiodic qualities of the magnetograph. In Section B (Mr. Campbell and Mr. Dye) a standard mutual inductometer for a maximum of 1 millihenry has been constructed; on the lowest range the whole scale will be equal to the microhenry, extended to 100 times this amount by dial coils. Means of accurately testing precision search coils with the aid of the magnetic fields of solenoids were investigated, and an accuracy within one part in 1,000 was found to be attainable. Various tests were carried out in connection with magneto condensers, compass magnets, search coils for horseshoe magnets, etc.

Resistance of the Electric Spark.

The author measures the resistance of the electric spark produced in an oscillating circuit of known capacity, inductance and resistance. One series of tests, in which the capacity and inductance are kept constant, shows that the resistance of the spark diminishes as its length increases. In one case the resistance of the spark was reduced from 0·0293 ohms to 0·007 ohms as the length of the spark was increased from 1 mm. to 10 mm. This shows that the resistance of the spark may be likened to that of a metallic resistance, an increase of temperature increasing the formation of ions, which become more numerous as the spark lengthens, thus improving the conductivity.

On the other hand, the charging potential varies with the length of the spark, and the tests are not strictly comparable unless they are reduced to a constant charging voltage. When this is done and the results are reduced to the same charging energy, the resistance is found to increase with the length of the spark, and the resistance per unit length of spark is not constant. This quantity is fairly constant for spark lengths lying between 3 and 5 mm. and then decreases. (F. Beaulard de Levaizan from *Comptes Rendus*, April 29th, 1918: *Revue Generale de l'Electricite*, August 3rd, 1918.)

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DIELECTRIC LOSSES IN CONDENSERS USED FOR TECHNICAL PURPOSES.

Dr. Grunberg has tested glass, hard paper and mica condensers for their behaviour under alternating tensions of low frequency. It was found that with glass the efficiency decreases with the periodicity, and that the losses with rise of temperature increase very rapidly, and that with increase of tension they increase by more than the square. With hard paper, with decreasing frequency, a still greater drop in the power-factor occurs than is the case with glass, while with mica the power-factor is better than with the glasses tested. *Verluste im Dielektrikum technischer Kondensatoren in Ztschr. des Oesterr. Ingenieur und Architekten-Vereines*, July 26th, 1918.

THE ORIGIN OF THE WORD "SPARK."

When electrically charged wires are brought near each other we see what we call a "spark." We see a spark from falling meteors, from the firefly, from the struck metal and from the burning brand. What appeals to the eye we call the "spark," but originally it was what appealed to the ear that gave us the root of the word. It was not the appearance but the sound that became a "spark."

Long before electricity received careful human consideration, or spark phenomena were classified, our Aryan ancestors started the little root "sparg" on its growth through the languages of that original tongue. These Aryans, some eight or more thousand years before our era, knew what fire was and used it. They were acquainted with burning wood and knew that it gave out a crackling sound. When they spoke of that sound they used the word "sparg," and it survived the ages and has become our "spark."

This "sparg" grew into the Teutonic base "sprak" from which has come numerous words that imply making a crackling noise. In Anglo-Saxon it is "spearca," meaning exactly what we mean by "spark." Our Danish brother has it in "spraga," signifying to crackle, and in Icelandic it is "spraka," with the same meaning. The sound is always in the word, whether it accompanies the "spark" or not.—*Telegraph and Telephone Age.*

THE EINTHOVEN GALVANOMETER.

An interesting and clearly written article on the Einthoven Galvanometer, pointing out its application to the photographic recording of radio signals, appears from the pen of Samuel D. Cohen in our contemporary, the *Electrical Experimenter*. The writer first indicates the main features of the various types of ammeter and galvanometer, and then proceeds to explain the form devised by Professor Einthoven, who uses a fine single silvered quartz wire placed in an extremely powerful magnetic field. Several years ago the author constructed a very simple Einthoven Galvanometer. Although not so sensitive as the commercial one it gives fairly accurate results in experiments which he conducted in radio receiving circuits. The instrument was sensitive enough to record radio currents received from distant transmitting stations.

Briefly, the instrument consists of a wooden base on which is mounted an extremely powerful electro-magnet, the pole faces of which are brought within an extremely short distance of one another. A long single silvered quartz fibre is carefully suspended between the two pole faces in such a manner as to be secured at each end and held under a fair tension. Through this fibre the received current is passed. Whenever the current passes, the fibre is displaced in the concentrated magnetic field to a degree dependent upon the strength of the current. The pole pieces are pierced in such a way as to allow the insertion of an optical eye-piece, through which the displacement of the wire can be observed in a magnified form. The method of noting the displacement of the wire when carrying a current is shown

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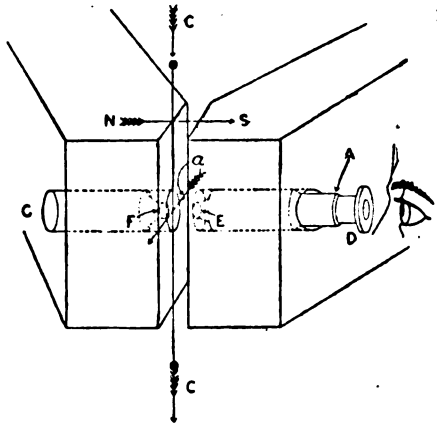

FIG. 1.

in Fig. 1. An eye-piece AE is inserted in a hole in one of the magnet poles, and the light is projected by the tube C and the lens F. The wire is stretched between the points CC, and with the flow of the current in the direction indicated by the arrows, a deflection is obtained as shown by the horizontal arrow "a," which is at right-angles to the magnetic field NS. Even a minute movement by the wire is greatly magnified by the eye-piece. For projecting on a screen the eye-piece is removed, and by sending a powerful light ray through C, we see the image of the middle part of the wire on the screen. The screen is placed one metre away from the wire, inasmuch as the deflection will vary with the distance. The instrument may be calibrated to note the amount of current necessary to produce a deflection of one millimetre division at one metre distance. This is a standard of calibrating all types of galvanometers.

It was found from actual experiments in determining the sensitiveness that the string will be displaced one millimetre for currents as small as 10^{-12} ampere $\frac{1}{1,000,000,000,000}$ (or one-trillionth of an ampere). Several millimetres or even centimetres of deflection can be obtained with the aid of the optical instrument and with currents of values of 30 to 40 micro-amperes (one micro-ampere = one one-millionth ampere). It is thus seen that the instrument is extremely sensitive.

Some of the most valuable features of this instrument are :—Its quick action, its dead beat, and its quick period of swing, this being due to the almost negligible weight of the moving part, its moment of inertia being extremely small. Also it possesses practically no self-induction or capacity. It was found that with a wire of standard length and thickness, which is one-thousandth of an inch thick, that the period of the wire is $\frac{1}{1,200}$ of a second. This is small enough for practically all speeds of code reception used by commercial radio companies.

To determine the period of the string by actual measurement is a difficult problem. However, the following may be found of interest, especially to the more advanced student of electricity: If a short current be sent through the string by means of suddenly tapping a key connected with the string, it is given a jerk and is displaced through a distance d (at the centre). It then swings back to zero and then past the zero point, due to the slight moment of inertia which it possesses. Calling this distance X, the point is thus d–X from it, where d–X is less than d. If a damped oscillation is sent through the wire, the string does not actually come to rest for a definite time. During this time there may be a complete vibration from which the natural period t/n can be ascertained. If the string be made to cast a shadow over an illuminated slit through which the light passes when it is displaced, and this light falls on a rapidly travelling band of a highly-sensitive photographic film, and a tap be then given with a key or switch, a record of the movement of the string is obtained. If the rate at which the film travels is known, it is a simple matter to calculate the period of the string of the galvanometer.

The string has a shorter period if its length be shortened or its tension increased, and the damping of the oscillation can be effectually increased if a twist be given to one end of it.

It is thus seen from the above discussion that the character of the string, its material and manner of suspension has a great deal to do with the sensitivity of the instrument.

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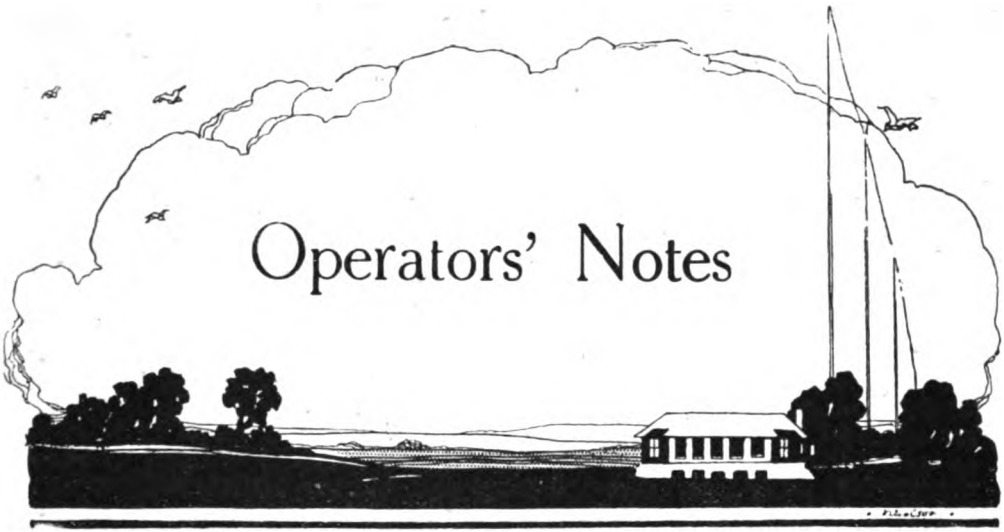

Theory and Practice at Sea

By REDAX

It is a regrettable fact, but one which cannot be denied, that the good intentions with regard to study and self-improvement with which most operators start their sea-going career seldom show any fruition in results. Some years of experience has shown me that most junior operators, when making their first trip, produce from their bags a few standard textbooks—sometimes even a miniature library of technology, which they fondly hope will enable them to fit themselves for a better position. Sometimes they do, but more often they don't, for reasons which I hope to explain below.

Most of the trouble arises from a complete lack of definite aim, and ignorance of what knowledge is actually required, or even desirable, for the position of Marconi telegraphist on board ship. This is the reason why many an admittedly studious and conscientious "new chum" is referred to by his senior as "one of those theo-"retical blighters—not much use for real *work!*" Such remarks, when overheard by the "blighter" referred to, are usually attributed quite erroneously to jealousy; whereas, on the contrary, they are usually a fair indication of fact.

Whatever inflated ideas the new telegraphist may start with, he sooner or later must realise that his duties, baldly stated, consist in the rapid, accurate, and efficient transmission and reception of radiotelegraphic signals, and the keeping of proper records. It is better to be able to send twenty-five words a minute in Continental code, good formation and steady, than to transmit twenty words a minute in both American and Continental codes. A knowledge of the relative sensitiveness of galena, silicon, and iron pyrites is so much brain waste if you cannot adjust the carborundum detector of the tuner you are using. And ability to draw the circuits of half-a-dozen different "systems" arouses no enthusiasm if the possessor of this knowledge takes half an hour to "tune in" his signals.

There, then, is the secret of success for the man who wants to become efficient. Study what you *must* know before you study what is not essential. It is a very simple rule, but one which seems to be studiously ignored by many new men.

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It is an unfortunate fact that a number of wireless books afford very little practical help to the seagoing operator. I can also safely make the general statement that the more interesting a wireless manual seems to be, the less practical utility it possesses. Operators who allow their studies to be guided purely by whether the books are "interesting" or not will sooner or later find themselves possessed of quite a considerable collection of interesting facts, very little useful knowledge, and a totally unwarranted sense of self-importance.

In a word, they will be "theoretical blighters!" In case I may be misunderstood, let me say at once that I do not deny that the acquisition from books of really useful knowledge is interesting, once the study is properly tackled. It is the superficial interest of non-useful matter that is the lure. Place before the average new man an article on some foreign system (illustrated), and another article on the best way to tune in with a Marconi 31 crystal receiver. Which one will be read first? The article on the foreign system, of course; and which is the article more likely to be helpful in his work? Obviously, the second.

The operator who thinks he can ignore "book learning" altogether, and acquire all the necessary knowledge from his daily practice, is equally at fault. In books are enshrined the experiences of men who have acquired their knowledge laboriously and after many trials and experiments. To ignore the help that such men can give is to waste time and mental energy to an extravagant extent.

Assuming that the aim of the young operator is to become a really first-class radiotelegraphist, he cannot do better than compare himself with some senior man whom he knows to be a far better operator than himself. Wherein does the actual superiority lie? Is he a better telegraphist? Probably. How did he acquire his skill in this direction? By transmitting and receiving a large amount of traffic, either as a wireless man or as a landline telegraphist. Obviously, then, every opportunity should be taken to practise the telegraphic side, and a large amount of excellent practice is available in recording messages not actually destined for the ship, but merely overheard.

Secondly, is he quicker, more deft, and more certain in his handling of the apparatus? Most decidedly. This, again, comes from frequent handling. Rapid tuning, in particular, is the fruit of considerable experience, and can be practised every day on watch. In these times, of course, when it is necessary to keep the strictest watch on certain defined adjustments, the opportunities are more limited than in peace time, but they still exist in a measure, and should not be missed.

Thirdly, how does our senior man set about his work when a fault or breakdown occurs? A real fault or breakdown, not a P.M.G. fault, which is more in the nature of a disconnection than anything else, and is, in the main, superficial. Does he fumble round in a blind fashion, vainly hoping that it will come right somehow? Does he invoke his knowledge of the Telefunken quenched gap, or the Poulsen Ticker? No, he goes at it systematically, for he connects result with cause, and knows his apparatus intimately.

Here, then, we come to the true province of shipboard study. Learn your apparatus intimately and thoroughly. Memorise every connection, both externally and internally. Do not place too much reliance upon the theoretical diagrams—they are but a means to an end, not an end in themselves. Study every piece of apparatus to such a degree that you can practically see through the ebonite or wood. See that you understand the switchboard connections, from the back as well as the front, and if you have a chance to assist in a dismantling or installing job, or in a repair, no matter how "messy," jump at the opportunity, for the knowledge so acquired may be worth a great deal to you in the near future.

Don't try to study on a quiet watch until you feel that you have learnt all that is to be learnt from listening to signals, identifying them, reading through jamming and atmospherics, increasing the sensitiveness of your adjustments and hearing far, weaker signals. You won't reach this stage for a little while, and until you have

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reached it it is much the best way to "sit down and get it over." And furthermore, don't spend your time and use up pencils and stationery inventing and designing improved apparatus until you get some experience with the apparatus you have, and realise its capabilities. It is perhaps well to remember that just as many forms are wasted inventing new crystal holders as are used for recording messages. That nice convenient swivel-jointed, multicupped crystal detector you think is original is an old friend of all of us. We've all invented it, only to realise sooner or later that a wireless installation is a telegraph office, and not an experimental laboratory where adjustment can be made every minute. Good signals for half an hour are better than excellent signals for five minutes, and fancy holders with a multiplicity of adjustments are of no real utility.

When you have really mastered the apparatus you have to use, by all means extend your knowledge as far as possible, particularly by aiming at a quick realisation of the fundamental points of new circuits. At the present time there is no more fascinating study than the 3-electrode valve, and the numerous circuits with which it can be used, while the opportunity should be taken of acquiring all possible knowledge of continuous wave work. I mention these two branches as theoretical fields in which practical application may soon come your way.

Lastly, when it is time to sleep, sleep. The sea air has a remarkably soporific effect on new men, and if you sit up half your watch below when you ought to be tucked in your bunk, your efficiency on watch will be seriously impaired. It is dangerous to be drowsy anywhere—how much more so in the danger zone!

"The Scientific Problems of Radiotelegraphy"

UNDER the above title Professor J. A. Fleming has arranged to deliver a course of six lectures at University College, Gower Street, London, W.C.1. The first of these lectures was arranged for 5 p.m. on Wednesday, October 30th, and the others will follow weekly at the same hour on the same day of the week. The course is open to both members and non-members of the University of London, the fee for the whole set of lectures being one and a-half guineas. Application for tickets should be made to Walter W. Seaton, M.A., D.Lit., at University College. The comprehensive nature of the lectures may be gauged from the syllabus which we print below, and we understand that the same eminent lecturer has arranged to deliver three Cantor lectures at the Royal Society of Arts next February dealing with the same subject.

SYLLABUS.

LECTURE I. OCTOBER 30th. The Theory of Electromagnetic Wave production. Maxwell's Equations and their interpretation. Propagation of Electromagnetic Waves in Pure Dielectrics and in Conducting Dielectrics.

LECTURE II. NOVEMBER 6th. Antennæ or Wave Radiators. Theory of Directive Antennæ. Radiation Efficiency of Antennæ and Calculation of Radiation resistance for various types of Aerial. Predetermination of Aerial Capacity.

LECTURE III. NOVEMBER 13th. Electromagnetic Wave Detectors. The Fleming Valve and its derivative the Three-Electrode Valve. Valve Oscillators and modern modes of use of the Thermionic Valve as Oscillator and Detector in Radiotelegraphy and Telephony.

LECTURE IV. NOVEMBER 20th. Electromagnetic propagation over the terrestrial surface. The Energy losses. The problem of the Diffraction of long Electric Waves round a sphere. Formulæ for the Electric and Magnetic forces at various distances.

LECTURE V. NOVEMBER 27th. Atmospheric phenomena in relation to Radiotelegraphy. Atmospheric Stray Waves. Large scale researches on the effects. The Periodic Day, and Night variations of Signal Strength. Empiral formulæ and results.

LECTURE VI. DECEMBER 4th. Quantitative measurements in Radiotelegraphy. Measurement of Decrements, Inductances and Capacities. Signal Strength Measurement. Elimination of atmospheric disturbances.

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Our Italian Visitors

The Prince Colonna and Senatore Marconi on an Official Visit to England

IN February, 1896, at the age of two-and-twenty, Mr. Marconi arrived unobtrusively in England, a young engineer full of enthusiasm for his new discoveries, and took out his first patent. Two-and-twenty years later he visited us again, this time in company with the leading representative of one of Rome's most patrician families, as guest of His Majesty's Government and an official representative of Italy in England. We see a profound significance in the contrast of surroundings between the two visits, that of 1896 and that of 1918. Not only does this change constitute an eloquent testimony to the triumph of wireless telegraphy, but it forms a striking evidence of the altered attitude of the world towards scientific men. We have here an official recognition of the fact that science can do more towards linking nations together than is in the power of any other human agency.

The projected visit materialised early in September last, when Mr. Erskine, Councillor of the British Embassy in Rome, wrote to Senatore Marconi stating that Viscount Northcliffe, on behalf of His Majesty's Government, desired to invite him to participate in the celebration of Italy's fête in London, fixed for September 24th and 25th. Prince Colonna, the Mayor of Rome, received a similar invitation; which — in his instance — covered also a return visit to London's Lord Mayor, who had a short while previously fulfilled an official mission to the Italian metropolis.*

[*Photo: London News Agency.*

PRINCE COLONNA IN FIELD DRESS AND SENATORE MARCONI IN HIS NAVAL UNIFORM.

As the distinguished party passed through Paris, they were met by Sir Campbell Stuart, K.B.E., who accompanied them to London, which they reached on the evening of Sunday, September 22nd. At Victoria the Italian emissaries were met by the Lord Mayor and Sheriffs of London and escorted to the Mansion House. Amongst those present at the railway station to take part in this welcome was Prince Borghese, the Italian Chargé d'Affaires, acting on behalf of the Italian Ambassador, at the moment on a visit to Rome. Prince Colonna and Senatore Marconi made a joint statement to the Press,

* We published in THE WIRELESS WORLD for October (page 407) a picture of Sir Charles Hanson greeting the Italian scientist in that city, reproduced from a photograph taken on that occasion.

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emphasising the strength of the historic bond uniting the two countries and closing with the following sentence, to which the subsequent German armistice overtures have given special point :

" United to you by similar ideals, we shall continue with you in the war, " until victory—final and complete—shall have been achieved."

London has never surrendered itself so whole-heartedly to a celebration of Italian comradeship as during the days of the sojourn there of these two distinguished men. A huge demonstration in Hyde Park cheered a series of enthusiastic speeches, and passed resolutions of fraternal greeting. The band of the Royal Regiment of Italian Carabinieri, which arrived at Folkestone on Saturday, September 21st, naturally constituted an imposing feature in the celebration, and was enthusiastically welcomed everywhere.

On Monday, September 23rd, Prince Colonna and Senatore Marconi were received by King George at Buckingham Palace, where His Majesty conferred upon the Prince the Grand Cross of the Order of the British Empire. Later on in the same day they lunched with Lord and Lady Northcliffe, dining at night with the Lord Mayor previous to visiting a performance at the Alhambra.

On the morning of Wednesday, the 25th, which was selected as the special day for official functions, the Prince and Senatore attended a solemn Requiem Mass for the repose of the souls of Italian soldiers and sailors fallen in the war. This was celebrated in the Catholic Cathedral at Westminster by Bishop Butt, Cardinal-Archbishop Bourne presiding, whilst Italian soldiers mounted guard at the Catafalque.

In the afternoon came one of the most memorable luncheons that have ever taken place at the Savoy Hotel. France, America, Italy, Belgium, Portugal, Greece, China, Serbia and Montenegro, to say nothing of numerous British colonies, were all officially represented. Three great speeches were delivered by Lord Northcliffe, Senatore Marconi and Prince Colonna, respectively. The two former dealt with

[*Photo: Newspaper Illustrations.*

THE FAMOUS CARABINIERI BAND LEAVING BUCKINGHAM PALACE TO TAKE PART IN THE CELEBRATION.

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[Photo: News Illustrations.

PRINCE BORGHESE, THE ITALIAN CHARGÉ D'AFFAIRES, WITH GENERAL MOLA.

politics and war, and we have already referred to their oratorical efforts elsewhere (see page 456). The latter, who used his own language, dwelt upon the mutual sympathy traditional betwixt Italy and England.

The function at the Albert Hall in the evening of the same day will long be remembered by all who took part in it. The building lends itself to spectacular effect. The colour scheme produced by the scarlet and gold of the massed Guards bands blended in harmonious balance with that of the black and silver uniform of the Carabinieri, whilst the predominantly fair hair of the English bandsmen contrasted forcibly with the swarthy locks of the Italians. Floral decorations, uniforms in great number and variety, masses of our wounded heroes in their hospital garb of butcher-blue, combined with flags of every description to add brilliance to the scene.

On the evening of Friday, the 27th, the party left King's Cross by the night mail for Scotland, accompanied by Lieut.-Col. Sir Campbell Stuart and Lieut. Gordon Robinson, R.N., to pay a visit to the Grand Fleet. They reached Edinburgh at 1 a.m. on Saturday, September 28th, and motored to Hawes Pier. They proceeded on board the ——, where they were entertained by the Admiral, subsequently lunching at Admiralty House with the Commander-in-Chief, Admiral Sir Cecil Burney. In the afternoon, shortly before 6 p.m., our Italian guests returned to Edinburgh. At 7 o'clock the party were entertained at dinner by the Lord Provost of Edinburgh and left Scotland's famous capital at 9.30, reaching London once more on Sunday, September 29th.

Senatore Marconi's Franklin Medal

THE Franklin Medal awarded to Senatore Guglielmo Marconi on May 15th has been lost at sea. In our September issue, under the title of "A Distinguished Trio," we published a descriptive article on the Franklin Institute, in which an illustration of the medal together with an account of its institution and ceremony of award appears on page 325.

The medallion, with accompanying certificate, was presented in Philadelphia to the Italian Ambassador, who received it on behalf of Senatore Marconi, and it was despatched to him by Ambassador Cellere on a transatlantic liner. The ship was attacked by a German submarine in mid-ocean and sunk, the trophy, together with the certificate, going down with it. This handsome gold medal will be duplicated and the duplicate forwarded to Senatore Marconi as soon as expediency permits.

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Wireless Telegraphy In the War

BE LOYAL TO YOUR DEAD.

RECENTLY the ether has been vibrant with messages of peace. This wonderful medium does not concern itself with the question whether they may be real or hypocritical aspirations in that direction; it simply "notes" their passage. We have often enough insisted upon the importance of words, whether spoken, written, or ether-transmitted: their potentialities for good or evil are immense, and as much harm may be wrought by ill-considered words as by hasty action. After all, however, it is only when linked with deeds that words possess intrinsic value. When the imminence of being found out caused Hamlet's guilty uncle to sink upon his knees and pray for forgiveness, the answer which he got through the medium of his own conscience was expressed in his soliloquy:

> "My words go up, my thoughts remain below.
> Words without thoughts never to Heaven go."

By "thoughts" Shakespeare intended us to understand that sincerity of purpose which must find expression in action, if action be possible.

This was the logical attitude taken up by President Wilson in his reply to the recent German petition for peace. He did not deny the potentiality for good of the enemy's words, but pointed out that he could only give credit to such potentiality if it were accompanied by actions.

The Germans have utilised, and continue to utilise, radiotelegraphy throughout this war in a way that has never been possible before, and the items which have appeared in the Press afford little more than an indication of the great mass of messages which they have radiated, directed towards securing respite, if only temporary, from the Allies' military pressure. None of these messages, as yet, appear to indicate any realisation on the enemy's part of the seriousness of the reparation which must be made, or of the drastic precautions which the Allied Powers must take in order to ensure freedom on a firm foundation for the future. We not only owe this as a duty to ourselves and to our descendants, but to our dear dead. They have passed the supreme test and have surrendered their lives, not that we may render useless their sacrifice by haste to end the present bath of blood at the price of a muddled peace. The other day, as I was pondering over this side of the question, it seemed to me as though the air were full of wireless messages radiated from their disembodied souls. And the messages which they appeared to be endeavouring to drive home upon my consciousness may be summed up in the words: "We died for

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[Courtesy of "Flight"

GERMAN ACKNOWLEDGMENT, BY SIGNAL, OF THE RECEIPT OF AN AEROPLANE WIRELESS MESSAGE.

' freedom ; do not betray its hallowed cause. Until the soil be really ready for the " Sower's seed take not your hand from the plough."

THE PROSTITUTION OF SCIENCE.

In one of our earlier volumes we pointed out that an outstanding feature of the present world-struggle has been the systematic utilisation by the Hun of all the resources of science in order to inflict gruesome damage and destruction of human life. Poison gas in hideous variety, to say nothing of the submarine and the aeroplane, those marvels of construction by which men have recently overcome the difficulties of sea and air, furnish but outstanding instances. Wireless telegraphy comes in the same category, constituting, as it does, the connecting link whereby both the new developments are rendered efficient. Now our enemies are beginning to realise the Nemesis which such a line of conduct entails. One of the matters which invariably looms large in their aspirations for peace consists of the return to them of the colonial possessions which they have lost. Mr. Long, the British Secretary of State for the Colonies, put the problem in a nutshell when he pointed out that " It will not be " merely as valuable possessions that Germany would regard them ; she would regard " them as bases for wireless telegraphy, for airplanes and for submarines." The statesmen of our allied countries have given voice to the same sentiment. When war broke out, German vessels at sea in the different quarters of the globe received, according to plan," wireless messages announcing the fact and instructing them to take the nearest path to safety. In a vast number of cases this meant their taking

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refuge in a neutral port, and during the earlier period the harbours of South America were full of German ships interned there in order to escape the grasp of the British Fleet. If an unregenerate Germany were to be put again in possession of her territory overseas, think what wireless messages would be received as soon as she thought herself once more prepared for a predatory campaign. The word would go out that German merchantmen should take refuge in the fortified bases which would be prepared to receive them, there to be fitted with means of war upon the shipping of the simpletons who had given back the opportunity of establishing them. A message would pulse through the ether to the submarines which, either openly or secretly, would be lurking there, to go forth and sink without trace every vessel they encountered. It is here that the lack of imagination, still characteristic of the British populace at home, must be reckoned with. Our Colonial cousins realise the gravity of the danger, and their statesmen insist on every possible occasion upon the necessity for its avoidance.

An Italian Submarine.

We have noticed a curious effect resulting from the suppression of war exploits performed by members of our own naval and military Forces, in combination with the publicity (which can be allowed without detriment to the public interest) in the case of our enemies.

Take, for instance, the case of secret wireless, as employed by enemy agents and spies. In a number of instances, after these have been discovered and brought to naught, it is possible for the Censor to allow some account to be published, and we

[*Official Photograph*

R.A.F. OBSERVER WITH HIS WIRELESS TRANSMITTER TO KEEP IN TOUCH WITH OUR GUNS.

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have been treated to a number of such instances from time to time. But the same freedom does not hold good with regard to the activities on our own side; so that, despite the fact that the British Secret Service is one of the most efficient in the world, so far are its activities removed from public gaze that we should not be at all surprised to find a number of people who believe that secret organisation for obtaining information in enemy countries constitutes a German monopoly. We are all the more glad, therefore, to notice the recent publication in the daily press of a Vienna telegram to the *Frankfurter Zeitung* revealing the suspected existence of a wireless installation at Prague, which appears to have been giving the Austrian authorities considerable anxiety. The German newspaper adds the detail that "a particularly "close search has been made for this installation, which is thought to be of a movable "variety, consequently making the search very difficult."

Again, with regard to the submarines. We learn so much of enemy activities that, if it were not for occasional revelations of our own and those of our Allies, this branch of warfare also might have seemed to be neglected by our own side. Of course, here again such is far from being the case, and the officially promulgated narratives of allied deeds of derring-do which are given publicity from time to time avail much to dispel the false impression. One of the most striking of these narratives recently issued has for its hero a young Italian submariner who "put down" an enemy craft in the Adriatic. The narrative is best told in his own words:

"We were cruising, half-submerged, when we saw something (*here he made a "dramatic pause*). It might have been driftwood. We were not sure. It was 800 "yards away, and we tried to close it. It moved away. Then we knew."

The Italian commander took the risk of losing his adversary altogether, and dived on a course which he calculated would take him under the enemy and bring him up on the other side. He was successful; the Austrian shark was still lying awash when he came up, and just in the position to be torpedoed. The impact of the Italian explosive split the adversary in half, and the following day the enemy wireless stations ashore kept sending out calls in vain. "U 5! U 5! U 5!" they spluttered incessantly; but U 5 was lying on the bed of the Adriatic and could make no reply.

The "Sparks" Club

A New Institution Catering Specially for Wireless Men

UNDER the auspices of the Bloomsbury Institute, a Club has been organised with its headquarters at the Institute premises, Shaftesbury Avenue. The aim of its founders is to provide social recreation for the large number of Wireless Operators and students who are obliged, in many cases, to live in London far from their family circles and friends. The Club places at the disposal of its members a lecture room (also utilised as a social rendezvous), gymnasium, reading room, writing room, etc., the very moderate subscription amounting to but half-a-crown per quarter. The Club nights are Monday, Wednesday and Friday in each week, and the membership at present amounts to about eighty. Facilities are provided for tea and light refreshments, whilst after 7 p.m. members have the privilege of being accompanied by lady friends. The supervision of the establishment is undertaken by Mr. Spurgeon, assisted by a band of voluntary helpers from the Bloomsbury Church.

Grand concerts were held in the lounge on Friday, the 4th, and Tuesday, the 22nd October, at 7 p.m., the former to inaugurate the Winter Session. A large number of instructors were present, and a long and varied programme was carried through with great éclat.

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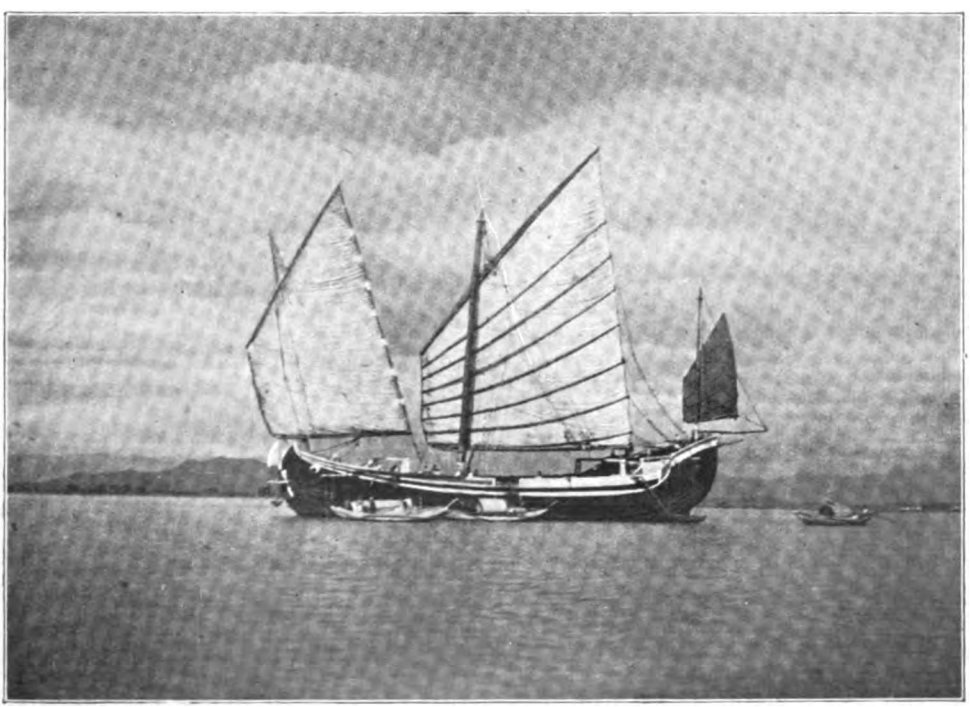
Meanderings in a Yellow World

By HAROLD WARD

THE Yellow Sea, or, as the Chinese call it, Hwang-hai, is rightly so named, as its colour is decidedly yellow. This peculiar tint is due to the mud brought down by the Hwang-ho, or Yellow River, from the interior of China, and is most striking in its effect, especially on a bright, sunny day.

Not only does this colour pertain to the sea, but also to the land, people and products of the surrounding districts. Yellow is the one predominant colour of China as a whole. The natives are yellow, the soil seems tinged with the same hue, and yellow predominates in the Chinese flag. When you speak of the products of China you naturally think of Shantung silk and preserved ginger, to say nothing of bamboo or street dogs. And are not all of them yellow? To the writer the colour yellow always raises thoughts of China; that is why I gave this article its present title. The dictionary includes "sensational" as one of the meanings of yellow, and surely China is sensational enough for anyone.

Proceeding up the river from the sea towards Shanghai the first item of interest we met with was the old "battle junk" shown in the accompanying illustration. Exactly how old this craft is I would not like to say, but it is still going strong. At the foot of the forward mast you will notice an eye painted on the bows, the purpose of which peculiar adornment, common to most small Chinese craft, is rather obvious, for, as my "boy" informed me: "Him no eye, how can see way?" We Westerners are so dense in some respects. Please observe the sampans alongside, with their curious little arched canopy of plaited, split bamboo.



OLD CHINESE BATTLE JUNK, WITH SAMPANS ALONGSIDE.

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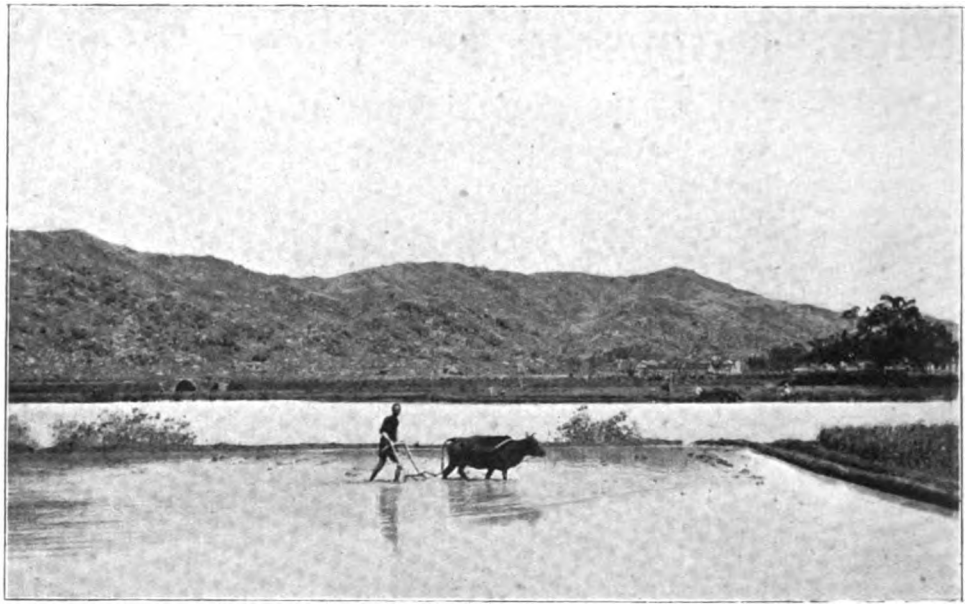

PLOUGHING A RICE FIELD.

The word "sampan," on being interpreted, means, I am told, three boards. Whether this is so or not I cannot say, but properly speaking they merely consist of two sides and a bottom, the bow and stern being formed by the convergence of the three component parts. Sampans are not rowed in the ordinary manner, but are propelled by a single oar at the stern or on occasion by a sail.

A little further up we saw a number of rice fields being ploughed by oxen, and at a later date I was fortunate enough to secure the illustration on this page, which clearly shows that the ploughing is done while the fields are in a flooded condition. The plough is of an ancient type, such as might have been used in England centuries ago; however, ancient or not, it seemed to serve its purpose.

About an hour later we anchored in mid-stream opposite the wharves of Shanghai, to be immediately boarded by a wild-eyed, pigtailed lot of stevedores, who tore off the hatches and scurried about in a frenzy of endeavour to discharge our cargo, their eagerness to work being explained by the fact that they were paid at "piece-work" rates.

Since the perfume exhaled by a perspiring Chinese coolie is far from choice, and since my cabin was surrounded with dozens of them, I loaded my camera, chartered a sampan, and retreated ashore. Here at first, being in a low quarter, I was worse off than ever. The smell of real, genuine, low-class Chinese "chop" shops defies description, and every other shop seemed to be cooking some abomination. However, after a short ricksha ride, I arrived on the Bund, the main water-front street, and found myself in a thoroughly modern European thoroughfare, with tree-lined paths and large shops. Paying off my human steed, I—well, I don't think I need tell you just what I did, but it was a hot day and very dusty.

During our stay I paid a visit to the old city of Shanghai, the wall of which has since been pulled down. This city, entered by crossing the moat which surrounds it, and by passing through the enormous gates of its huge defensive wall, was China proper; the China you read about; China as it was umpteen years ago. The streets were so narrow that the houses—save the name!—almost met overhead. This overhang, coupled to the fact that each house or shop had long advertising

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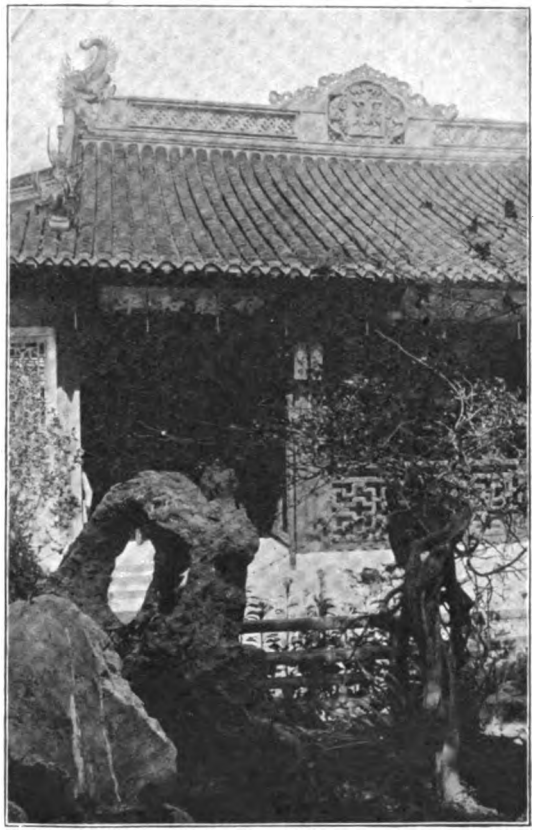
flags hanging from their upper windows, almost blotted out the daylight. It was not only hopeless but unwise to attempt photography, since the dwellers of this strange town are firm believers in "the evil eye." Exactly what "the evil eye" is I do not know, but apparently all foreigners possess it; so does a camera.

I peeped into strange shops and witnessed the execution of strange crafts—the crafts of the jade worker, the ivory carver, and the painter on silk. My investigations were of the briefest, as I was constantly pestered by the pitiful supplications of loathsomely diseased and maimed beggars. At times I was most uncomfortable, as the staring, yellow faces were not always sympathetic or friendly.

During my wanderings I chanced upon what is supposed to be the original scene of the famous Willow Pattern Plate. As to its authenticity I will not vouch, but the water is there, the queer high, round bridge is there, also the house and tree, whilst over the bridge Chinese maidens are constantly tripping as depicted on the plate in question. Try as I would, I could not disperse my following of beggars and mangy dogs sufficiently to get a clear view for my camera.



ROCK GARDENS IN A CHINESE TEA-HOUSE.

Around the lake or river over which the bridge is built is a native market, where one buys singing(?) crickets in tiny bamboo cages, or untempting rice cakes, not to mention many other weird commodities. I here witnessed, until driven away by my pestilential beggars, the performance of a person who was apparently a public entertainer of some sort. He was fantastically dressed, and his evolutions were most weird, but what he was supposed to be doing I do not know.

By the aid of judiciously applied coin I was able to enter, through several locked doors, a high-class tea-house whose beautiful rock gardens and little artificial lakes supplied the matter for another of my illustrations.

My next venture of interest was to a large temple where some ceremony of importance must have been taking place, judging by the number of crackers which were fired off and the quantity of "joss" smoke which filled the place and my eyes with pungent clouds like a blacksmith's shop on a busy day. Priests in strange attire strolled around while the congregation made to Buddha offerings of food, burned prayer papers, or joss sticks.

On another voyage to Shanghai I made a journey some distance into the country, and among other curious things saw the catching of large numbers of small edible water tortoises—one could hardly term them turtles. As they were caught they were thrown into flat-bottomed barges, where they lay in a horrible squirming mass of legs and long heads.

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GROUP OF CHINESE PEDLARS AND COUNTRYFOLK.

It was during this country walk that I obtained the photograph of the interesting group shown on the left. The gentleman sitting down next to the little boy is a sweetmeat hawker who wanders from village to village with his wares in two baskets slung on a bamboo pole across his shoulders. He ambles along in a peculiar shuffling jog-trot, beating a drum and crying his wares in a sing-song kind of chant in order to attract possible customers from the houses, which are generally surrounded by a high bamboo palisade as shown in the illustration. Most Chinamen are very averse to having their photo taken, and I have so frequently been asked how I manage to get them to look into the "eye" of my camera that my little subterfuge may be useful to other photographers. It was simplicity itself. I held the camera sideways and pretended to be taking a picture on the other side of the road, then, whilst they watched my efforts, I snapped them. They did not know which was the front of my camera.

Among other ports of minor interest which I visited in the Yellow Sea was Tsing-tau, or, as it used to be called, Kiau-chow. Tsing-tau at this time, long before the war, was a German naval station complete with wireless station, floating dry dock and repair shops, in addition to which there was a pretty typical German town built on the hillside overlooking the sea. Needless to say, photography here was out of the question, but I did roam around a lot, and saw many things, including the permanent trenches with barbed wire entanglements, covered by guns on small hills, and crossed by bridges all ready mined to be blown up at a moment's notice.

CARGO COOLIES AT SHANGHAI.

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I remember talking to some German officers in a café, and how they were bragging about their defences, stores for a long siege, etc. Yet, in spite of all these precautions, they put up a very faint-hearted resistance to the attacks of our gallant little ally, Japan. I tried hard to visit the wireless station, but was unable to do so.

Here, too, or rather just outside the town, I saw acres and acres of growing "monkey nuts," the same nut that our American cousins call "pea-nuts," and I was very surprised to discover that they grow, not on trees, but under the ground, like potatoes. The local method of thrashing and winnowing this crop was primitive in the extreme. A fairly windy day was chosen, the nuts placed on large sheets on the ground, and then thrashed by hand with an ancient-looking wooden flail, after which a woman, using a large wooden shovel, flung the nuts high into the air, when, of course, the wind blew away the light husks, whilst the heavy kernels fell into a fairly regular heap.

All the little villages round about had their public corn mills, which consisted of a huge round slab of sandstone, on top of which was a large millstone capable of rotation round a fixed centre pillar. Some of these must be very old judging from the depth and smoothness of the track worn by the constant use of the machine.

I watched with interest the building by natives of a German villa, the most curious part of which process was the manner in which bricks for the upper stories were passed up. One man on the ground wielded a kind of long-handled baker's slice, by the aid of which he flung the bricks, placed on the flat end by another man, high into the air, whilst a third man on the top of the scaffolding caught them with great dexterity on a similar appliance. I was astonished at their skill and speed.

As the man in a daily American newspaper cartoon says, "them was the happy days," especially with regard to wireless work in this part of the world. There were hardly any land stations, and but few ships were then equipped, so that the operator was not overburdened with onerous telegraph duties.

A TYPICAL CHINESE TEMPLE.

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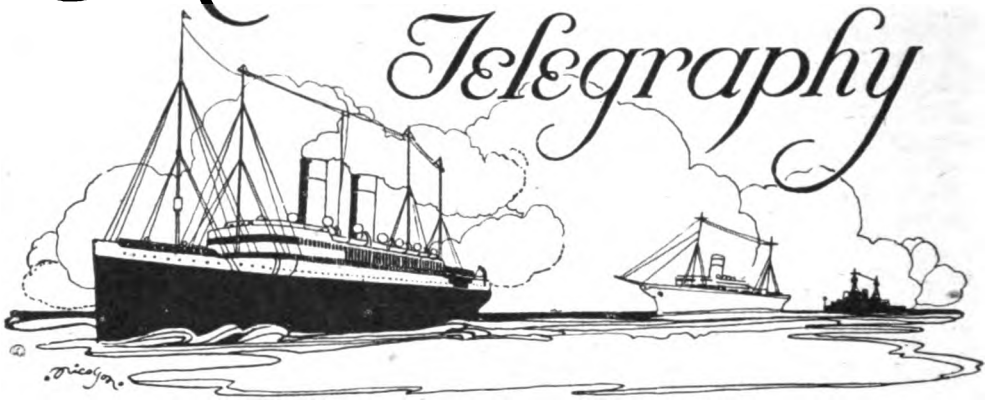
Maritime Wireless Telegraphy



Idealism—Losing Life to Save It.

It was no mere happy coincidence which led Lord Northcliffe, at the Savoy luncheon, held in honour of Italy's Day, on September 25th, to dwell emphatically upon the fact that "no single living human being has saved so many lives as Marconi." This is the side of wireless work which has always held predominance in the mind of its great protagonist. We find no inconsistency between his passion for the preservation of life and the fact that the eminent Italian scientist takes his place amongst the most enthusiastic supporters of war *à outrance* with the Central Powers. Occasions frequently arise when it is necessary to lose life in order to save it. Many a young wireless operator serving at sea has given practical demonstration of this truth by sticking steadfastly to his post in the midst of danger and death, and losing his own life to save those of his fellows.

In our opinion the fact that this ideal of life-saving plays so large a part in the psychology of Marconi should be considered not altogether irresponsible for the practical manifestations thereof, which have recurred so persistently as to become widely known as the "Marconi tradition." The Italian inventor has shown how ether waves, whose very existence was unknown for so many centuries, can produce effects profoundly affecting practical everyday life in many directions. Tradition and Idealism, just as impalpable, produce far more numerous and striking effects on human existence than does what Francis Bacon called upon us to reverence under the title of the "Dry Light of Reason." Every member of a great organisation becomes affected by the spirit which permeates the corporate body to which he belongs, and some day we may find a great discoverer who will not merely be able to demonstrate to us the existence of the psychological waves to whose agency such effects are due; but will teach us how to put ourselves in resonance with the reception of beneficial impulses and detuned to those that are malevolent.

Senatore Marconi shines out as a striking example of the fact that idealism is not merely not antagonistic to practical work but a direct incentive thereto. In this particular he forms a fitting representative of his motherland, as whose mouthpiece he addressed the distinguished assembly at the Savoy.

This combination of the ideal and practical was touched upon by Lord Northcliffe in the course of his opening speech, when he referred to the "two Italies, the Old and the New, both splendid Italies." As a matter of fact, of course, the well-wrought creation of what is to-day the "New" becomes by the mere efflux of time

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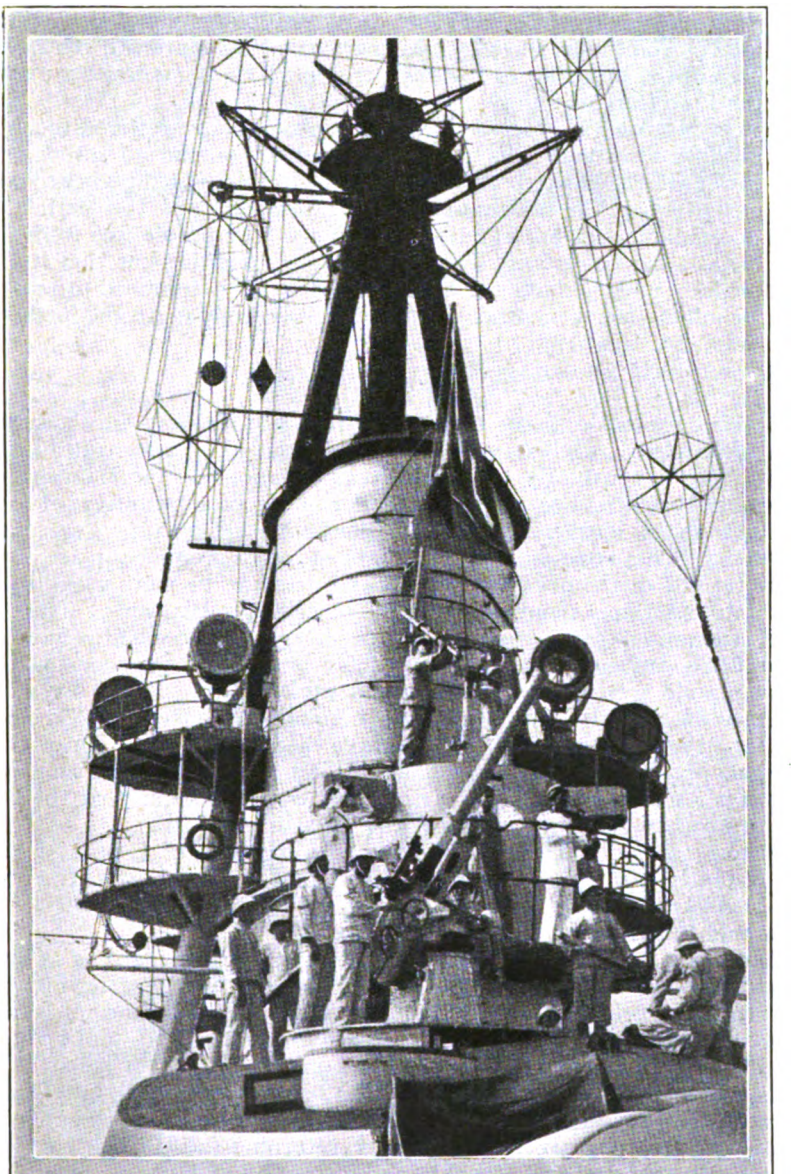

[*Italian Naval Official.*

AN ARMOURED TURRET, WITH ITS WIRELESS FITTINGS, ON AN ITALIAN BATTLESHIP.

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the admired achievement of the "Old"; so that Lord Northcliffe's division is really one of temporality. The Italians have a proud tradition behind them, not merely of thoughts nobly expressed but of practical work carried through in the true spirit of the craftsman. Anyone who desires to know what that spirit was, may see it for himself in such easily accessible books as the autobiography of Benvenuto Cellini, a world-famous goldsmith, sculptor and engraver of the sixteenth century. Cellini was a citizen of the Free City of Florence, and much the same traits are to be found all over the Free Italy of to-day.

Senatore Marconi, in his speech on the occasion above referred to, dwelt upon the special difficulties with which Italy has had to contend all through the forty months during which she has been engaged in hostilities, waged by her more particularly against Austria, the traditional foe. He touched upon the sacrifices she has made and is making, her anxiety to see the Yugo-Slav people free from subjection to Kaiser Karl, and her intense longing for peace; pointing out that it is just this longing for peace and the saving of life that renders her determined to prosecute the war to a definite issue, even although this must inevitably mean the further sacrifice of lives.

THE MARCONI TRADITION.

The reference made above to the fact that the idealism which animates the "Father of Wireless" has been so persistently displayed by those who adopt wireless as their calling is constantly receiving exemplification in our Magazine, and the devotion to duty which arises out of it has become the proud tradition of the Service. It is a tribute to this idealism that, when a short while ago an appeal was made to the youth of Great Britain to qualify as wireless operators, a prominent place was given to the patriotic side of the question. No young man can be more usefully employed in his country's services than when engaged on such wireless work. The enemies of England stigmatised her in former days as hopelessly decadent. She has given the lie to such a slander in many stricken fields; but in none have her sons performed more honourable service than in this radio work at sea. Month by month THE WIRELESS WORLD, under the heading of "Among the Operators," records in the briefest way the gallantry of those who have died in the execution of their duty. But the gallantry of those who *live* is none the less prominent; and we hardly know whether it is a matter of regret, or a matter of congratulation, that the list is too numerous for us to deal with, even by way of passing mention.

Glancing casually through the number of accounts of U-boat sinkings, one meets constantly with such references as the following, which we extract merely as a sample, selected almost at random. The writer is narrating how a ship went down through enemy action in the North Sea:—

"Under the lee of the forecastle ten men stood waiting, strong swimmers all, "who had unselfishly given up places in the boats to others: preferring with noble "daring to trust their own fate to the Caley floats and the chance of being shortly "picked up. Amongst them was the *wireless operator*, who—until the dynamo "stopped—had remained at his post sending out the appeal for help."

This characteristic of cool intrepidity has become proverbial, and figures under such a category in a recently communicated account entitled "A Fisherman's Fight," wherein is narrated how six armed trawlers, returning to a British port with their cargoes of fish, encountered, fought, and drove off a large German submarine cruiser. The narrative ends with the pregnant sentence: "The R.N.V.R. wireless "operator has received official mention for just those qualities *which are becoming* "*recognised as normal* in the men of his calling."

One little incident in this tale of heroism indicates the *sang-froid* of Britishers, especially of those who "ply their business in the great waters." The fishermen, true to their calling, could not be induced to quit the spot where the German shark disappeared without gathering in the dead or stunned fish caused by the explosions.

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Notes of the Month

Dutchman or Hollander?

We recently received a letter which illustrates the undesirability of utilising the term "Dutchman" to denote a subject of Queen Wilhelmina. The nomenclature originated in England, and is nothing but a corruption of *Deutscher* (German). Hollanders themselves do not use it, nor is it employed by any other nationality except our own and that of our American cousins. Under present circumstances to confuse any member of a civilised country with the Germans comes perilously near an insult.

The letter to which we refer came from a wireless operator in Rotterdam who complained of an item in our September issue (page 335), in which an American wireless man telling the story of his being torpedoed speaks of the German pirate as "the Dutchman."

Being ourselves familiar with the American slang habit, which dubs any member of Teutonic origin as a "Dutchman," we had not guarded against this misconception, and insert this note in case any other readers may be under the same misunderstanding.

Compulsory Wireless in New Zealand and Australia.

In the *New Zealand Gazette Extraordinary*, published at Wellington, New Zealand, on August 1st, appears an Order in Council to the effect that every British seagoing ship of 1,600 tons gross tonnage or upwards, registered in New Zealand, in respect of which a licence to instal wireless telegraph apparatus is or has been granted by the Minister of Telegraphs, shall be provided with a wireless telegraph installation, and shall maintain a wireless telegraph service, and shall be provided with two certified operators, together with suitable accommodation for the apparatus and operators.

Further, the same Order enacts that all masters or owners of vessels of over 1,600 tons gross register must apply for a wireless licence before the 20th day of August, 1918, and equip their vessel with wireless where and when required by the New Zealand authorities.

The effect of this Order in Council will be that a large number of well-known New Zealand traders will shortly be equipped with wireless installation which have not hitherto carried radiotelegraphic apparatus; and, furthermore, will establish an increased demand for qualified wireless operators to man those vessels.

We learn through the medium of a cable from Melbourne, published in *Lloyd's List*, that a similar rule has been established in Australia.

Spitzbergen.

The British expedition to Spitzbergen in the Arctic Ocean has recently returned to England. Germany possessed a wireless installation on the island, set up by Prince Pless and Count Zeppelin in 1912, with direct communication to Berlin. This station has long since been destroyed.

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A Thermionic Valve Slopemeter

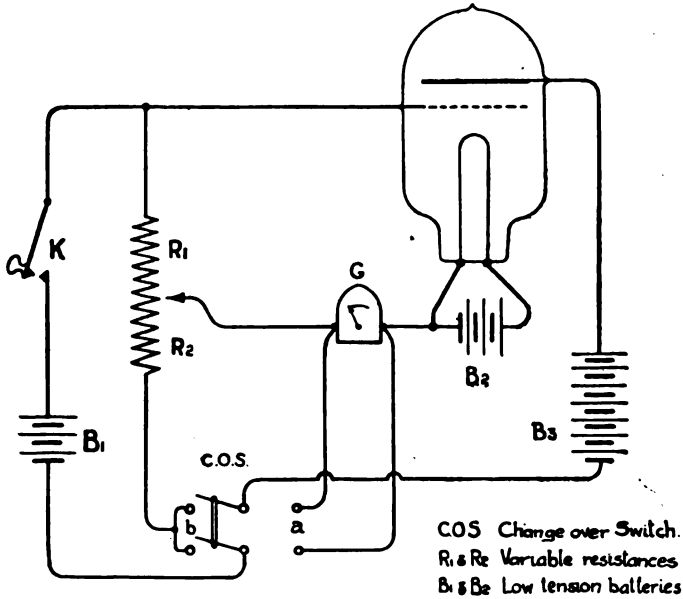
By E. V. APPLETON, M.A., B.Sc., R.E.

THE performance of a three-electrode valve as an amplifier of either audio or radio frequency oscillations is usually interpreted in terms of the characteristic curves of the valve in question. In every valve the static potentials of both the grid and the plate with respect to the filament affect the magnitude of the plate current and the magnitude of these effects is known if we know particulars of the grid voltage-anode current curve (for constant plate potentials) and of the plate voltage-anode current curve (for constant grid potentials). But as a ready aid in the interpretation of a valve's action we require to know the slopes of these curves at any particular operating point. For example, the effectiveness of a valve as a relay and amplifier depends primarily on the slope of the grid voltage-plate current characteristic. Also, according to Latour's definition * of amplifying power it can be shown that maximum amplification is obtained with a valve when the extra plate circuit resistance has a value equal to the reciprocal of the slope of the plate voltage, plate current, curve.

Let the magnitudes of the plate voltage, plate current, and grid voltage be denoted by V, I, and v respectively. Experiment shows that I is a function of both V and v. Langmuir † has shown that we may write

$$I = A\,(V+Bv)^{3/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

(where A and B are constants) as the approximate expression for the middle parts of the curves of a hard valve. We can define the slope of the I–v curve as $\left(\frac{\delta I}{\delta v}\right)_V$ and the slope of the I–V curve as $\left(\frac{\delta I}{\delta V}\right)_v$.



COS Change over Switch.
R1 & R2 Variable resistances
B1 & B2 Low tension batteries
B3. High tension battery.
K. Key.
G. Galvanometer.

Fig. I.

From (1) we get by differentiation :

$$\left(\frac{\delta I}{\delta v}\right)_V = \frac{3}{2} AB\,(V+Bv)^{\frac{1}{2}}$$

and

$$\left(\frac{\delta I}{\delta V}\right)_v = \frac{3}{2} A\,(V+Bv)^{\frac{1}{2}}$$

Therefore

$$\frac{\left(\frac{\delta I}{\delta v}\right)_V}{\left(\frac{\delta I}{\delta V}\right)_v} = B \quad . \quad . \quad (2)$$

It is thus clear that the ratio of the slopes for any particular operating point is constant. Thus, if we find this ratio and also the value of, say,

* Latour, *Electrician*, December 1st, 1916.

† Langmuir, *Proc. Rad. Eng.* September, 1915.

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$\left(\frac{\delta I}{\delta v}\right)_V$ for different values of V, we also know without further investigation the values of $\left(\frac{\delta I}{\delta V}\right)_v$ for various values of V.

The apparatus shown diagrammatically in Fig. 1 affords a ready method of obtaining these quantities, the full determination of the characteristics being unnecessary.

The two adjustments to be made are as follows:

(1) With the change-over switch in position (*a*) and the key K not closed the galvanometer G reads the normal plate current. If R_1 is adjusted so that the deflection on G is unaltered when the key K is pressed the slope of the grid voltage-anode current curve $\left(\frac{\delta I}{\delta v}\right)_V$ is given by the relation:

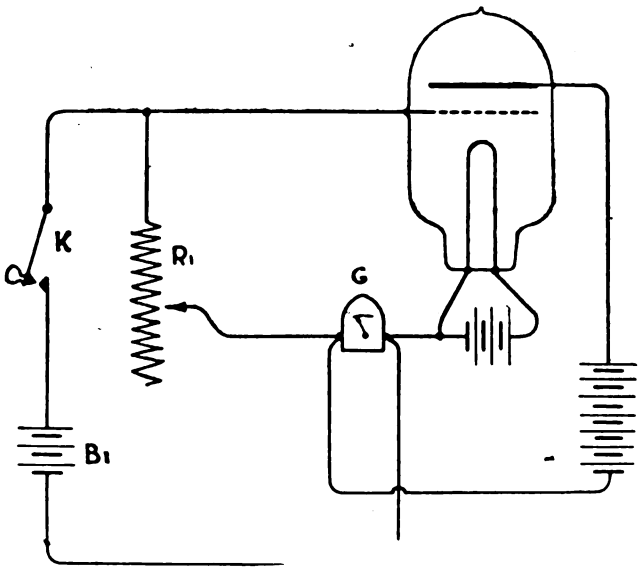

FIG. 2.

$$\left(\frac{\delta I}{\delta v}\right)_V = \frac{1}{R_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

(2) With the change-over switch in position (*b*) and the key K not closed the galvanometer G reads the normal plate current. If the ratio of R_1 to R_2 is varied so that the deflection on G is unaltered when the key K is pressed the ratio of the slopes of the curves—*i.e.* $\left(\frac{\delta I}{\delta v}\right)_V \Big/ \left(\frac{\delta I}{\delta V}\right)_v$—is given by the relation:

$$\left(\frac{\delta I}{\delta v}\right)_V \Big/ \left(\frac{\delta I}{\delta V}\right)_v = \frac{R_2}{R_1} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Thus the absolute values of the slopes of both characteristics are known. For practical working it is useful to note that the sensitiveness of the apparatus increases with increase of the voltage B_1.

PROOFS OF FORMULÆ.

Fig. 2 shows the circuits of Fig. 1, redrawn with the change-over switch in the (*a*) position. Before the key is pressed the normal plate current passes from right to left through the galvanometer. Let us assume that when the key is pressed a current X passes through the resistance R_1, and also through the galvanometer. A positive potential $R_1 X$ is thus applied to the grid, and the resultant increase of plate current is $R_1 X \left(\frac{\delta I}{\delta v}\right)_V$. For there to be no change in the galvanometer reading we must have these two oppositely directed currents equal—*i.e.*,

$$X = R_1 X \left(\frac{\delta I}{\delta v}\right)_V$$

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Therefore $$\left(\frac{\delta I}{\delta v}\right)_v = \frac{1}{R_1} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Fig. 3 shows the circuits of Fig. 1, redrawn with the change-over switch in the (*b*) position. When the key is pressed let us assume that X is the current through R_1 and R_2. Thus a positive potential of magnitude $R_1 X$ is applied to grid and a negative potential of $R_2 X$ is applied to the plate. The positive grid potential tends to increase the plate current by the amount $R_1 X \left(\frac{\delta I}{\delta v}\right)_v$ and the negative plate potentia' tends to decrease it by the amount $R_2 X \left(\frac{\delta I}{\delta V}\right)_v$. If the plate current is unaltered we must have:

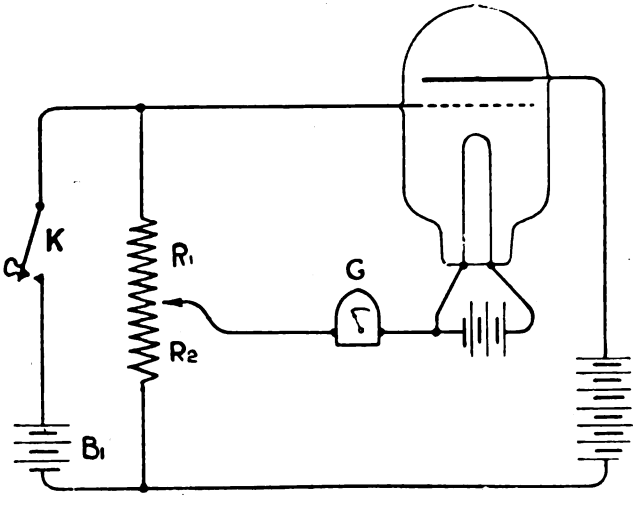

FIG. 3.

$$R X \left(\frac{\delta I}{\delta v}\right)_v = R_2 X \left(\frac{\delta I}{\delta V}\right)_v$$

Therefore

$$\left(\frac{\delta I}{\delta v}\right)_v \Big/ \left(\frac{\delta I}{\delta V}\right)_v = \frac{R_2}{R_1} \quad . \quad (4)$$

Note.—It has been assumed that the resistance of the galvanometer is small compared with the resistances R_1 and R_2. As R_1 and R_2 are always fairly large this is the case in practice. If extreme accuracy is required the resistance of the galvanometer can be allowed for by a simple calculation.

Customs Duty on Wireless Telegraph Outfits

A DOMINION of Canada Order in Council, passed April 5th, provides as follows:—When imported materials, on which customs duties have been paid, are used in the manufacture of wireless telegraph apparatus supplied to vessels in Canada subsequent to January 1st, 1918, there may be paid a drawback of 99 per cent. of the duties paid on the materials so used. Provided, however, that such drawback shall not be paid unless the duty has been paid on the materials so used within three years of the date when the wireless telegraph apparatus used has been supplied to the ship equipped therewith.

The drawback may be paid to the manufacturer of the wireless telegraph apparatus, subject to the following conditions, viz.: The quantity of material used, and the amount of duties paid thereon shall be ascertained; satisfactory evidence shall be furnished in respect of the manufacture of the wireless telegraph in Canada and its installation on board the vessel equipped therewith. The claim for drawback shall be verified under oath before a collector of customs, to the satisfaction of the Minister of Customs, in such form as he shall prescribe, within one year after the apparatus has been supplied to the vessel in Canada. The Minister may also require, in any case, the production of such further evidence as he deems necessary to establish the *bona fides* of the claim.—*Telegraph and Telephone Age.*

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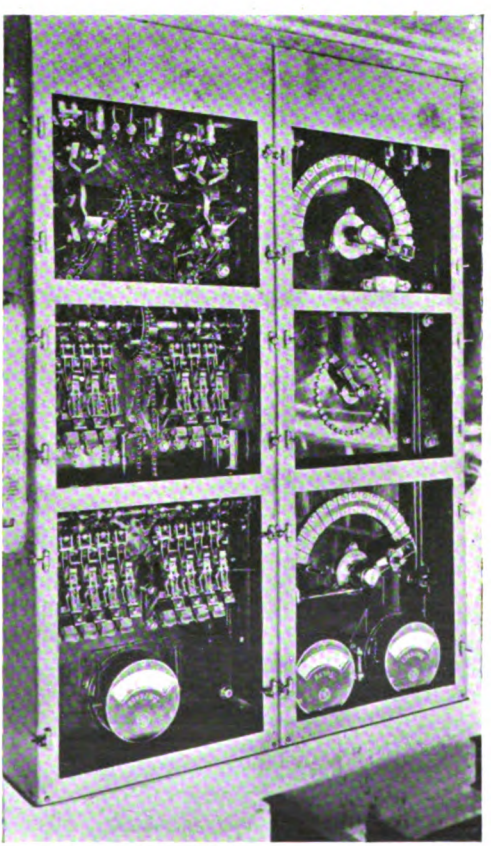
Wireless Girdles the Globe

The Most Striking Achievement Yet Recorded in Radiotelegraphy

WHEN first the possibility of sending wireless messages across the Atlantic was mooted, a distinguished British scientist remarked that considerable difficulty would be experienced in maintaining a chain of vessels to carry out the project. Even at as recent a date (alas! it seems a weary while ago to most of us) as the outbreak of war, quite an appreciable number of folk believed that transmission between England and America was carried on by a system of relays. The war has brought home to the general public the falsity of such a belief. Now that a distance of 12,000 *miles* has been traversed at a single stride, the most inveterate sceptic will surely be forced to lay aside his Doubting Gospel.

The facts are these: A series of trials of some new Marconi apparatus were carried out in the course of the present summer by the managing director of Amalgamated Wireless (Australasia), Ltd. Having succeeded in reading wireless communications radiated from Carnarvon, the well-known Marconi station in North Wales; he asked that special messages should be sent him as a test. So successful were the results obtained that Mr. Godfrey Isaacs invited Mr. Hughes, the Premier of Australia, and Sir Joseph Cook, the Minister of the Australian Navy, to transmit two messages by radiotelegraphy to the Antipodes. The event proved a glorious triumph for wireless telegraphy, and constitutes one of the most striking demonstrations which has yet been witnessed of its present powers, as well as of the immensity of the future developments that lie before it. The Marconigrams sent by the two Australian statesmen accomplished their 12,000 miles journey with the speed of light, and had been published by the Press some hours before the receipt of the cable confirmations which had been despatched simultaneously. The Sydney Chamber of Commerce cabled a message of congratulation and asked that a reply thereto might be sent by wireless. This request was complied with, and the ether waves carried that reply with the same accuracy as the two earlier



A CONTROL BOARD AT THE SENDING STATION

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THE ANCHORAGE OF ONE OF THE TEN MASTS. THIS WILL GIVE SOME IDEA OF THEIR GIGANTIC SIZE.

messages. As Sydney lies almost at the furthest point in the hemisphere from Carnarvon, it is no exaggeration, but a sober statement of fact, to state that wireless has girdled the globe.

The message of Mr. Hughes ran as follows :

"I have just returned "from a visit to the battle-"fields, where the glorious "valour and dash of the Aus-"tralian troops saved Amiens "and forced back the legions "of the enemy. I am filled "with greater admiration than "ever for these glorious men "and more convinced than "ever that it is the duty of "their fellow-citizens to keep "these magnificent battalions "up to their full strength."

The text of Sir Joseph Cook's Marconigram was :

"The Royal Australian "Navy is magnificently bearing "its part in the great struggle. "The spirit of sailors and "soldiers alike is beyond "praise. The recent hard "fighting has been brilliant "but makes reinforcements imperative. Australia hardly realises the wonderful "reputation which our men have won."

Carnarvon Station is fully described in Volume II. of THE WIRELESS WORLD, in an article entitled "Transocean Wireless Telegraphy," pages 212 to 220. It was opened for service in May, 1914.

Spotting for the Guns

THE two illustrations in our Wireless and the War pages (445-8) depict incidents connected with airmen spotting for artillery. Both sides utilise similar methods, and one of our pictures illustrates a British airman, the other shows German artillerymen engaging a signal. One of our contemporaries recently emphasised the difficulties encountered by fliers engaged on the spot. His own battery has its guns painted with queer stripes and covered with brushwood, whilst the enemy in many cases camouflages his artillery in a similar fashion. For locating his target the airman is assisted by his marked map ; but for getting into communication with his own battery he relies upon prefixing his wireless message with the special code letters which identifies him to the battery he is addressing. It is through this same medium of wireless that he communicates his instructions to the gunners and advises them when they make a hit.

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Among the Operators

It is our sad duty, month by month, to record the death of the brave operators who have lost their lives at sea by enemy action and other causes in the wireless service of their country. Owing to the necessity of preventing the leakage of information likely to assist our adversaries, the names of ships and localities of action cannot be published. With the exception of Mr. L. H. Wright, who died from natural causes, the lives of the operators mentioned this month have been sacrificed as the result of hostile activities. Both on our own part, and on that of our numerous readers, we extend to the parents and relatives of these young men, who so nobly upheld the "wireless tradition," the deepest sympathy in their sad bereavement.

MR. THOMAS GLENMORE KINION LORD MINTY, born at Dulwich on May 4th, 1900, was educated at Edward Alleyn's School, East Dulwich, and before taking up wireless telegraphy served in the Engineering Branch of the London Telephone Service, G.P.O. He received training in radiotelegraphy at Marconi House School, and on completing his course gained the P.M.G. Certificate. Mr. Minty was appointed to the operating staff in June of this year.

A Lanarkshire man, MR. ANDREW IRVINE MCBROOM was born at Dalserf on April 23rd, 1901. His education, commenced at Longrigg Public School, was completed at Airdrie Academy Higher Grade School, after which he held a position as clerk to Messrs. Shirlaw Allan & Co., auctioneers, of Hamilton. Under the supervision of Marconi instructors, he was trained at the Royal Technical College, Glasgow, where he qualified, in February, 1918, for the P.M.G. Certificate, and was shortly after given an appointment in the Marconi Company.

MR. EDWARD COEN, who hailed from Scrabby, Longford, was born on January 19th, 1890. He successively attended the Secondary School, Waterford, and the College, Galway, receiving the certificate for having passed the King's Scholarship Competitive Examination, with honours, and obtaining a scholarship of £100 in College Drumcondra, Dublin. Later, he held an appointment at the Central Telegraph Office, G.P.O., London, as temporary telegraphist, leaving to take up a position with Messrs. Harrods, Ltd., Brompton. Being the possessor of the P.M.G. Certificate, he sought and obtained a vacancy on the seagoing staff of the Marconi Company in April, 1916.

Born at Croston, Lancashire, on October 8th, 1899, RAYMOND TREVOR WORDSWORTH HOWE pursued his studies at the Preston Grammar School. His course of instruction in radiotelegraphy was undertaken at the Liverpool Wireless Telegraph Training College, and, after being granted the P.M.G. Certificate, he was placed on the Marconi Company's operating staff in January of this year.

MR. PAUL WILLIAM PROUD was born at Silverdale, Carnforth, on September 2nd, 1899, and received his education at Bickerton House School, Birkdale, and the Modern School, Southport. He commenced a course for wireless operators at the Liverpool Telegraph Training College, and, gaining the P.M.G. Certificate, entered the service of the Marconi Company in February last. His body was recovered from the sea, and the funeral, which took place at the Birkdale Cemetery on September 5th, was attended by eight of his brother operators.

Brixton was the birthplace of LESLIE HARDWICKE WRIGHT, on October 8th, 1899. He was a pupil at Dulwich College, and subsequently secured an appointment as temporary clerk in the office of the High Commissioner for the Union of South Africa. During the recent recruiting scheme for wireless operators he offered his services, and was accepted as a student at Marconi House, and qualified for the P.M.G. Certificate. Mr. Wright was given an appointment as operator by the Marconi Company in September, 1917.

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ROLI OF HONOUR.

READING FROM TOP (LEFT TO RIGHT) :—OPERATORS COEN AND McBROOM; HOWE AND MINTY; WRIGHT AND PROUD.

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Instructional Article

NEW SERIES (No. 8).

EDITORIAL NOTE.—Below we give the eighth of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

CHEMICAL ACTION.

BY the law of conservation, if a number of atoms combine to form a molecule the weight of the latter is equal to the sum of the weights of the atoms. Similarly, if a molecule is split up (or decomposed, as chemists say), the total weight of the new molecules produced is equal to the weight of the original molecule, or, if atoms only are produced, their weights added together are equal to the weight of the parent molecule. Hence, if any mass gains or loses weight it must have gained or lost atoms. A distinction must be recognised between a gain in weight due to simple *accretion*, or a loss due to purely mechanical subtraction, and gain or loss due to the formation of new molecules, or, in other words, *chemical action*. The increase in the weight of an aerial wire due to incrustation by carbon from a ship's funnels is a case of accretion, but the increase in its weight due to the action of "weather" is the result of chemical action. The bluish-green colour of an aerial which has made a few trips to sea is owing to the presence of copper compounds formed by the action of furnace fumes, sea-spray and rain. Aerials are sometimes enamelled in order to prevent this deleterious action.

Chemical action may be :

(1) **A redistribution of the atoms composing the molecules of different substances.** Such redistribution may be **analytic** or **synthetic.** By an analytical chemical action a compound is resolved into its elements.

Example : If Mercuric Oxide is strongly heated it is decomposed into mercury and oxygen.

Synthesis is the reverse of analysis, being the production of a compound by the direct bringing together of its elements.

Example : If a mixture of the elements oxygen and hydrogen is subjected to the action of an electric spark a compound—water—is formed.

(2) **A combination of two molecules into one.**

Example : If the fumes of hydrochloric acid are allowed to come into contact with those of ammonia, a white solid called Ammonium Chloride is formed. Both of the substances brought together are compound gases and they unite to form a more complex solid compound.

(3) **A re-arrangement of the atoms of a molecule** whereby it acquires entirely different properties, although still composed of the same number and kind of atoms. It is supposed that the agency, generally heat, which brings about such an action in some way alters either the movements of the atoms or their relative positions within the molecule. The classic example of this is the case of **Ammonium Cyanate.** On being warmed this substance is converted into **Urea,** quite a different material, which is otherwise manufactured by nature and is found amongst the waste products

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of the body; yet its composition is identical with that of Ammonium Cyanate. Both compounds are described as **isomeric** and are alluded to as **isomers** of each other. Amongst the carbon compounds cases of isomerism are very common.

Some *elements* are capable of altering their properties to such an extent that they present the appearance and behaviour of quite different kinds of matter. Such alterations are thought to be the result of a change in the *number of atoms in the molecule.* The phenomenon is known as **Allotropy,** and the rarest form which an element can assume is called an **allotropic modification** of the commonest form.

Examples: **Oxygen.** *A molecule of this gas contains two atoms. Under certain conditions another atom of oxygen joins this group and the resulting tri-atomic molecule is given the name of Ozone and is regarded as an allotrope of Oxygen. The peculiar smell which is noticeable in the vicinity of a spark discharge (in air) is due to the presence of ozone formed from the air by chemical action caused by the discharge.*

Carbon. *This element has three forms:* (1) *Diamond;* (2) *graphite;* (3) *ordinary amorphous carbon such as soot, bone charcoal, etc.*

Sulphur. *No less than four forms of this substance are known:* (1) *Rhombic crystals;* (2) *prismatic (needle-shaped) crystals;* (3) *plastic (in this form it is elastic);* (4) *amorphous (a whitish powder).*

Phosphorus. This element appears in two forms: (1) A waxlike, nearly colourless, highly inflammable solid, with the familiar luminosity in the dark; (2) a reddish powder, non-luminous, and not particularly inflammable.

CONDITIONS NECESSARY FOR CHEMICAL ACTION.

Contact. The most essential of the conditions which must be fulfilled in order to produce chemical action is that the two substances between which the action is to occur shall be brought into contact with each other. Many substances are so active that simple contact with others is alone sufficient to cause chemical action.

Examples: (1) *When pure nitric acid is poured on copper a violent action ensues, the copper rapidly disappearing. Copper nitrate, water, and a colourless gas called nitric oxide are formed, the action being accompanied by the evolution of heat. The bluish-green colour of a weather-beaten aerial is chiefly the result of the action of the free acid in rainwater upon the copper in the wire.*

(2) *In most cases of the oxidation of metals exposed to the air the mere* **contact** *of the atmospheric oxygen is sufficient, although in some instances—that of iron, for example—the presence of water is also necessary. Dry iron will not rust in dry air at ordinary temperatures.*

(3) *Quicklime (calcium oxide) is often used to absorb the moisture from the air in the region of the steel electrodes of a wireless transmitter, so that these shall not rust. The* **contact** *of the water vapour with the lime is sufficient and the action which takes place is a slow "slaking" of the lime, forming calcium hydroxide. When water in bulk is poured on quicklime a similar action occurs but is very rapid and so much heat is evolved that some of the water is vaporised.*

Thousands of other examples of action by contact could be given, but one more, a very familiar one, must suffice. When in the course of making up accumulator acid sulphuric acid is poured into water a very complex chemical action occurs, accompanied by the evolution of heat. That we have here more than a case of simple dilution is evident from the fact that notwithstanding the heat produced *there is a diminution in volume.* According to the proportions employed there are formed compounds called hydrates and cryo-hydrates, which are sulphuric acid in actual chemical combination with various amounts of water. If the mixture is made in the proportion of one molecule of acid to two of water the diminution in volume is about 8 per cent., and the compound formed is called hexabasic sulphuric acid, because its molecules contain six atoms of hydrogen.

Increased Temperature. Chemical action being, as we have seen, reducible to

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the movements of atoms or molecules it is not surprising, after what we have learned about the movements of these particles, to find that temperature is one of the most important of the conditions which induce chemical action. When two substances are brought together and chemical action does not take place until they are heated, this is a case in which we have to increase the energy of the atomic or molecular system from an external source. Let us attempt to form a conception of why this is necessary.

The atoms of a molecule have been likened to the members of a celestial system as regards their movements and positions relative to each other, but this analogy cannot legitimately be pushed very far and need be accepted by the reader only in such measure as assists him to form a mental picture of :

(1) A group of atoms forming a more or less stable system called a molecule.

(2) The re-arrangement or disruption of the system.

The earth moves in an elliptical orbit round the sun at a speed of about eighteen and a half miles per second, and for the sake of simplicity we will regard these two bodies as a complete system. Now, it is the attraction which the enormous mass of the sun has for that of the earth which, in the absence of a near body of still greater mass, keeps the system stable ; but in the calamitous event of the near approach of a body of greater mass than the sun, our planet would be attracted to it unless other bodies offered enough counter-attraction to avert the collision and permit the earth to pursue an orbit round its new sun. In any case the stability of our original system would be upset. As a side issue it is of interest to note that if matter were not conserved but were destructible, any such act of destruction, however trivial as regards the mass destroyed, would result in a general shift of the positions of the members of the solar system, and, in fact, this shift would be translated in varying degrees throughout the universe.

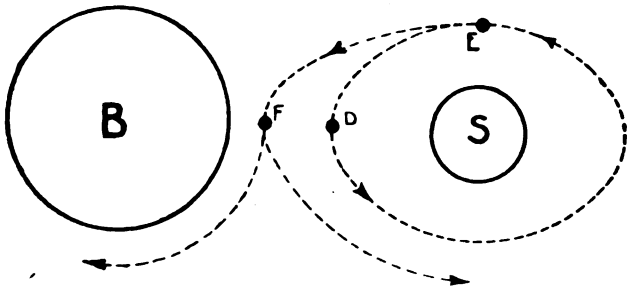

FIG. 32.

In Fig. 32, disregarding *B* for the moment, we see a diagram of the sun, the earth and the earth's orbit. Having grasped the idea that this system can be upset by the presence of a body which attracts the earth more strongly than does the sun, let us suppose that *B* represents such a body (drawn to the same scale), but that the distance between it and the nearest point to which the earth approaches it, *i.e.*, at *D*, is so great that as long as this distance remains the same the earth will not deviate.

Next, suppose that by some means the earth were caused to swing beyond its usual orbit, thereby passing nearer to *B*, say at *F*, and coming much more under the attractive influence of *B*. There would then occur the break-up of the originally stable sun group and the formation of another system composed of the body *B* and the earth, the latter, it is conceivable, adopting a new orbit round *B* by virtue of the counter-attraction of other celestial bodies.

We will now try to find a parallel to this amongst the tiny systems called molecules.

A molecule of **Mercuric Oxide** contains one atom of Mercury and one atom of Oxygen, and can be depicted as in Fig. 33 (a), the oxygen atom, O, being supposed to revolve round the mercury atom, Hg. This molecule is very stable, its component atoms having a very strong affinity for each other, so that a large amount of external energy is required to split it up. If we supply a moderate amount of energy in the

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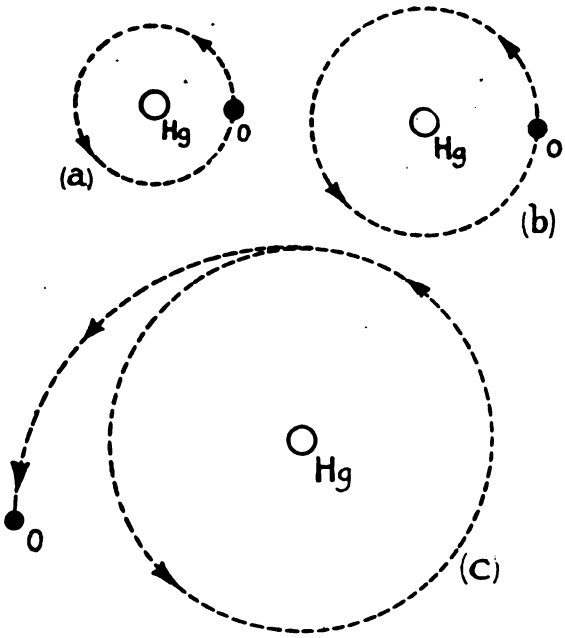

FIG. 33.

form of heat we may enlarge the orbit of O (Fig. 33 (b)), but the atomic system remains intact—that is to say, no *chemical* change occurs. A *physical* change does, however, ensue, and the Mercuric Oxide turns black. When this added energy is taken from the system by the process of cooling the compound reassumes its natural brick-red colour.

If we supply a considerable quantity of heat energy by bringing the substance to red-heat chemical action takes place. The orbit of O is so enlarged that the oxygen atom swings clear of the influence of Hg and escapes, leaving the mercury behind (Fig. 33 (c)).

The example just given is a simple one and we have yet to take a case of the *interchange* of the atoms of two substances. The preparation of **Hydrofluoric Acid,** which is used for etching on glass, affords a good example. A mixture of **Calcium Fluoride** (*Fluor spar*) and sulphuric acid is heated, and the gaseous hydrofluoric acid which is evolved is dissolved in water, in which state it forms the hydrofluoric acid of commerce.

A molecule of Calcium Fluoride contains { 1 atom of Calcium. 2 atoms of Fluorine.

A molecule of Sulphuric Acid contains { 2 atoms of Hydrogen. 1 atom of Sulphur. 4 atoms of Oxygen.

A molecule of each substance is shown graphically in Fig. 34 as a stable system. On bringing the two substances into *contact* with each other—*i.e.*, making the mixture referred to above—and applying energy in the form of heat, the atoms of each system, so we may imagine, have their orbits enlarged so that those of one system cut those of the other. Then by the laws of affinity new unions are made, for certain atoms are brought nearer to certain other atoms, whilst others are impelled from those with which they were originally associated; in general, there is a readjustment of the positions and motions of the atoms and the two original molecules are split up and their atoms are regrouped into three new molecules.

(*a*) 1 molecule of Calcium Sulphate, containing:
1 atom of Calcium.
1 atom of Sulphur.
4 atoms of Oxygen.

(*b*) 2 molecules of Hydrofluoric Acid Gas, each containing:
1 atom of Hydrogen.
1 atom of Fluorine.

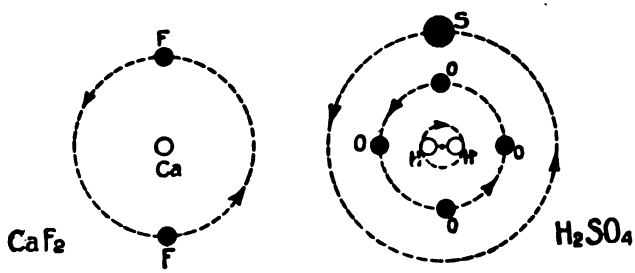

FIG. 34.

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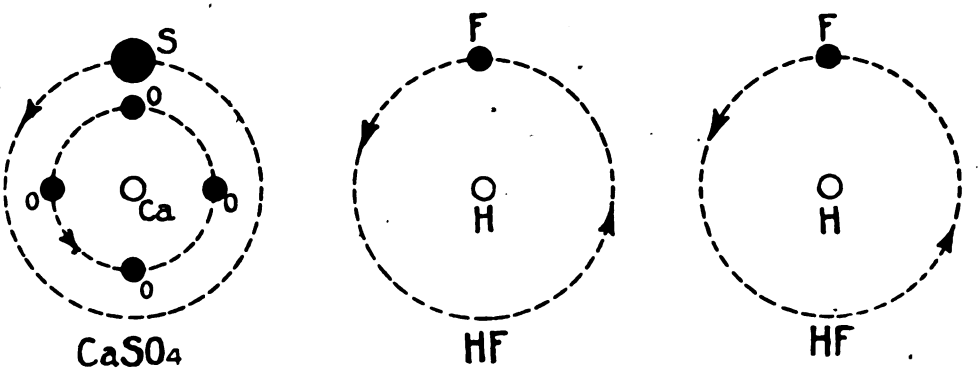

FIG. 35.

This final arrangement is depicted in Fig. 35. Note that **the number of atoms —*i.e.*, ten—with which we began** (see Fig. 34) **is precisely the same as the number of atoms present after the chemical action has taken place, but that the constitution and number of the molecules has altered.** This is typical of a large number of chemical changes.

The parallel between this case and that of the earth-sun example is shown by the similarity between what occurs in both instances when a member of a stable system is caused to move so far out of its original orbit that the attractive force between it and a third body becomes greater than that which binds the member to the system. Thus, in the case of the formation of hydrofluoric acid gas, the atoms composing the molecules of the calcium fluoride are swung from their orbits, thus being brought nearer to the atoms of hydrogen, sulphur, and oxygen which are swung to meet them. The result is that the atoms of hydrogen and fluorine approach each other, the attraction between them growing stronger, whilst that between them and the sulphur, oxygen and calcium becomes weaker, and is finally overcome. The hydrogen and fluorine then form a system by themselves, just as the earth and the body B would under the conditions described.

It was stated in a previous article that the stability of a molecule appears to depend upon the internal, original energy associated with it. This energy is heat, and we have just seen how heat affects the stability of certain compounds, but before leaving the subject it will be instructive to glance at a few instances wherein heat plays an important part in the production of allotropic modifications of elementary substances.

PROPERTIES AND ENERGY OF MOLECULES.

Sulphur has been referred to as possessing four different forms, but the point to which the reader's attention is directed is that **only one of these forms is notably stable,** that is, the rhombic. We may impart various amounts of energy to the sulphur molecule, causing its two atoms to move at those speeds which correspond to them in other forms of sulphur; but with one curious exception if the process is arrested this added energy gradually disappears, and the molecule repasses through the several states until it once more assumes its stable form. Thus sulphur, when heated to about 114 deg. C., melts to a clear liquid; when the temperature is raised further this liquid darkens and becomes more viscous. At 230 deg. it is black and extremely viscous. At a still higher temperature it becomes again liquid. It vaporises at 448 deg. C., and at 1,000 deg. C. it becomes gaseous. If this process is arrested at 448 deg. C. the substance repasses through the previous states and finally solidifies.

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(1) **Prismatic sulphur** at ordinary temperatures gradually breaks down into the stable **rhombic form.**

(2) **Plastic sulphur,** which is made by pouring boiling sulphur into cold water, breaks down at ordinary temperatures into the **rhombic form.**

(3) **Amorphous sulphur** is stable at ordinary temperatures, but becomes **rhombic** at 100 deg. C. In this case it will be seen that we have to *add* energy to a fairly stable form of this element in order to obtain the *very* stable one. Nevertheless it can be said that sulphur generally tends to assume the rhombic form, for even in the present case, when amorphous sulphur is prepared by the sublimation of sulphur vapour, *by far the greater part of the product is deposited in the form of rhomlic crystals.*

Examples (1) and (2) above show that those two forms of the same elementary substance are transitionary and dependent upon the energy of the system. Left to themselves the molecules in both forms probably lose energy, and in course of time revert to the stable form.

Again, in the case of carbon it is generally known that a form of this element closely resembling, if not identical with, the diamond can be produced from ordinary pure carbon such as is yielded by burning sugar. The process consists of dissolving the carbon in molten iron, which is then raised to a temperature of about 3,000 deg. C. The molten metal is then plunged suddenly into water until the surface of the mass is at a red heat ; from the inner core of the mass the carbon is deposited and contains fragments of " diamond." These are extracted by dissolving away the iron in acid.

What happens is this. A large amount of energy is added to the carbon and the slow process whereby this energy would be taken from it—*i.e.*, natural cooling—is abruptly disturbed by the plunge into water and the consequent enormous pressure exerted upon it by the iron. This appears to have the result of arresting the loss of energy whilst the carbon is in a transitionary state corresponding to the crystalline, adamantine form. It has been ascertained by direct experiment that burning diamond and burning amorphous carbon evolve different quantities of heat, showing that the two forms are associated with different amounts of energy. This would be expected after a consideration of the process just described.

(To be continued.)

Handwriting of Telegraphists

TELEGRAPHERS have always attached importance to the ability to write well with pen and pencil. Two operators may be equally expert as senders and receivers, but if one of them can write a good telegraph hand and the other cannot, then the former is regarded as the better operator.

Within the past year one of the Munsey publications conducted a penmanship contest for railroad and commercial telegraphers. There were about a thousand entries, the specimens coming from all parts of the United States and Canada. From the samples twenty-one winners were selected and prizes awarded.

An analysis of the exhibits showed that the lines of the famous old-time telegraph hand have been more successfully preserved on western railroad lines than elsewhere. Two reasons for this may be that train orders still are copied by stylus, and train dispatchers still copy with the pen ; also that higher salaries, as a rule, have been paid telegraphers on western lines than eastern railroads, and this condition has attracted westward the most competent all-round telegraphers.

It was demonstrated that thousands of telegraphers can to-day turn out copy comparing favourably with that of the stars of the seventies and eighties.—*Telegraph and Telephone Age.*

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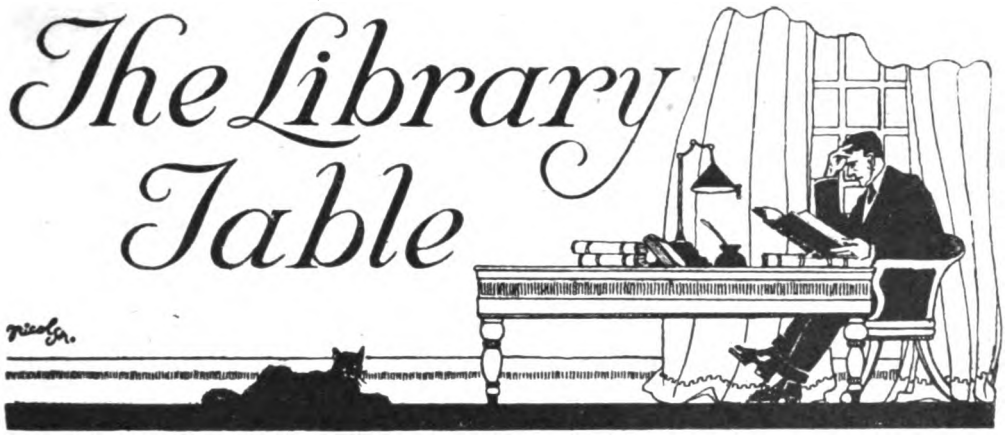
The Library Table



MAGNETIC MEASUREMENTS. A companion volume to the "Arithmetic of Electrical Measurements." By A. Risdon Palmer, B.Sc., B.A. London: Thomas Murby & Co. 1s. 6d. *net.*

Among the minor advantages conferred upon the world of science by wireless telegraphy must be counted the stimulation of the study of magnetism and electricity. Thousands of young men have now a sound acquaintance with these inter-connected sciences, due entirely to their pursuit of radiotelegraphic knowledge, and, as a result, there is a commendable improvement in the textbooks devoted to those subjects. Particularly do we welcome books which specialise in experimental work.

This volume is designed to cover the work on Magnetism which is concerned with such features as the measurement of pole strength, the comparison of magnetic moment, the evaluation of H and absolute determination of the value of the magnetic moment of a magnet, the period of vibration of a magnet, and the comparison of the intensity of magnetic fields by means of the vibrating magnetometer; Declination, Dip and Magnetic Potential. The author endeavours to cover the ground of the Matriculation and Local Examinations, and to reach in some details the Inter-B.Sc. standard.

The fifteen chapters of the book are each divided into three parts, the first containing suggestions for experiments, the second theoretical explanations, and the third illustrative examples and a number of arithmetical questions. In chapter 2 we find a description of how to make a magnetic balance (Hibbert's pattern). The author explains in his preface that in several different years he has asked the sixth form boys at the Polytechnic to make this balance at home, and many of them have produced an admirable instrument.

The explanations given are clear, and the questions and examples sufficiently numerous to make the book a very useful addition to the Science Series, of which it forms a part.

THE FLYING BOOK. Edited by W. L. Wade. 1918 *Edition. London: Longmans, Green & Co.* 5s. *net.*

This well-known annual, bearing for its sub-title *The Aviation World Who's Who and Industrial Directory*, is assured of a welcome amongst a wide circle of readers on the strength of the excellence of its previous editions, if for no other reason. The present volume will certainly add to the editor's reputation, containing as it does a large amount of interesting and up-to-date information compressed into a relatively small compass.

The book is divided into three parts, the first and largest being devoted to special articles on Aeroplanes in War, Naval and Commercial Aeronautics, Aeroplane Design and Construction, How to Control an Aeroplane, Aero Engines, Airships and

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Kite Balloons; descriptions alphabetically arranged of War Aeroplanes (as far as the present censorship will allow), an Historical Section, and a section of Aero Engines, these latter three being particularly well illustrated. In conclusion, we find a chapter on Records.

The special articles are highly informative and, being written in clear, non-technical language, will make a strong appeal to the general reader.

The article on Commercial Aeronautics is based on the paper read by Mr. G. Holt-Thomas before the Aeronautical Society of Great Britain in June, 1917, and although its substance is well known to all who closely follow aviation matters, it will be new to a large number of general readers. Mr. Holt-Thomas, who was the first man in this country to adopt aeronautics seriously as a commercial venture, demonstrates in a convincing fashion how, with present-day machines, a passenger service between London and Paris could be formed upon a profitable basis, for a fare of £5 per head.

Part Two, which is really the Directory and Who's Who, is highly valuable for reference purposes, and contains particulars of a large number of British, American, and Italian firms engaged in aviation. Readers who are fond of biography will turn with pleasure to the Who's Who for the life histories of prominent flying men and constructors. It has been considered advisable to omit all reference to active service officers, so as to avoid giving rise to invidious distinctions, and for this reason many highly interesting names are left out, but we still find a great number of famous men included, particularly the pioneers.

Part Three contains particulars of the Royal Air Force, of the decorations awarded to flying men 1914-1917, and other equally useful information, together with a table of air raids on the country during 1917. In this last we would like to draw the editor's attention to one or two trifling matters. Thus, the same raid is put down for July 7th and July 17th. On August 12th it is not stated whether 5.15 is a.m. or p.m., and on October 19th no time is given.

Another minor criticism we would make refers to the section on Aeroplane Engines. Here we were surprised to find no reference to the famous Liberty engine, of which many details have already been published in several quarters, particularly in America. Full details are, of course, withheld by the authorities, but much of interest has been revealed, and could be included here.

A review of this volume would be incomplete without a word of praise for the excellence of the illustrations and the general make-up of the book. No one realises better than ourselves the difficulties attendant upon the production of books in these times, and we heartily congratulate editor and publishers upon the manner in which they have performed their task.

ENGLISH-SPANISH COMMERCIAL CORRESPONDENCE. By Wm. Chevob-Maurice, A.I.L., and Andrés J. R. V. Garcia. London: E. Marlborough & Co. Wrapper, 1s. 3d. net; cloth, 2s. 6d. net.

This volume, in the words of the authors, is issued as a practical and reliable guide to proficiency in Spanish Commercial Correspondence, and as a useful and handy work of reference for the merchant and correspondent whose business brings him into communication with the Spanish. Messrs. Marlborough's language books are too widely known for us to need to describe the methods adopted, and it is sufficient to say that in this volume the usual high standard is well maintained. Numerous letters on most business topics and various trades are printed, with the two languages side by side in parallel columns. A student with a fair knowledge of Spanish will find this book of immense assistance in drafting business letters, and even the business man with a complete ignorance of the language will find no little help within its covers. The volume concludes with a useful list of commercial terms and lists of commercial abbreviations, money tables, weights and measures, and is certainly very practical in its arrangement.

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Personal Notes

New Appointment.

The South Wales Daily News states that Mr. Sidney Davies Reynolds, late of the Glandulais Mills, Pontardulais, has been appointed Government inspector of wireless stations in the East African Protectorate.

Matrimonial.

A large and distinguished company witnessed the nuptial ceremony on June 25th, at St. Michael's Church, Polwatte, Colombo, of Lieut. David Norman Walter Joel, R.N., wireless officer on the staff of His Excellency the Commander-in-Chief, East Indies Squadron, and Miss Mary Stewart Lockhart, daughter of Sir James Haldane Stewart Lockhart, K.C.M.G., LL.D., H.M. Commissioner, Wei-Hai-Wei.

The marriage of Mr. Walter Pursey and Miss Lilian Marguerite Ovens, the esteemed acting accountant of the Wireless Press, Ltd., was solemnised at St. James's Church, Muswell Hill, on August 31st. The bride looked charming in a gown of cream crêpe-de-chine. Her veil was kept in place by a wreath of orange blossom, and she carried a bouquet of white heather and carnations. Miss Ivy Fenn attended as bridesmaid. Amongst the numerous and beautiful presents received was a canteen of cutlery presented to Miss Ovens by her many friends in Marconi House. We offer congratulations, and wish Mr. and Mrs. Pursey happiness and prosperity in their married life.

MR. AND MRS. W. PURSEY.

Most Gallant Conduct.

One of H.M. Trawlers while minesweeping struck a mine and sank in a few minutes, the captain and twelve members of the crew losing their lives. Just after the explosion the wireless telegraphist, Richard Holdsworth, R.N.V.R., found Lieut. Law, R.N.R., in a

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R. HOLDSWORTH, R.N.V.R.

dying condition near the winch. Twice he was told to leave the ship and save himself, as it was then apparent that the officer was dead. He was, however, persisting in his endeavour to remove the body when the vessel sank. Holdsworth, who, by his devotion to the officer, had not had time to put on his lifebelt, was drowned after having sustained injury. According to members of the crew, had Holdsworth not stayed to get the lieutenant's body out of the ship he might have saved himself. The Lords Commissioners of the Admiralty have sent a letter to Holdsworth's mother, who lives at Burnley, expressing their lordships' warm appreciation of his most unselfish and gallant conduct.

AWARD.

The Distinguished Flying Medal has been awarded to Air Mechanic Wireless Telegraphist CYRIL R. DEELEY, who, although but eighteen years old, has seen considerable active service since 1917, when he enlisted as boy telegraphist in the R.N.A.S.

He is the youngest son of Mr. F. R. Deeley, managing director of the Chase Cycle Co., Ltd., Birmingham; Scout Commissioner for Acocks Green and Yardley.

Like many others who have won distinction during the war, he early identified himself with the Boy Scouts, and was an active member of the 1st Acocks Green Troop before joining up.

MR. J. P. MONTERO.

OBITUARY.

By the torpedoing of the Spanish steamer *Ramon de Larrinaga*, belonging to the firm of Messrs. Hijos de Jose Taya, on July 13th, the Germans have added the name of one more wireless telegraphist to their list of murdered. MR. JOSE PEREZ MONTERO, whose life was then taken, was born at Carthagena on November 22nd, 1895. At the age of nineteen he enrolled in the Spanish Navy, and was subsequently employed in the technical department of the Compania Riego y Fuerza del Ebro. Mr. Montero entered the service of the Société Anonyme Internationale de Télégraphie Sans Fil in February of this year.

PRIVATE G. PHILLIPS.

We learn with regret of the death, in France, of PRIVATE GEORGE PHILLIPS, lately a clerk in the Glasgow Depot of the Marconi International Marine Communication Co., Ltd. Born on September 22nd, 1896, he enlisted in Lovat's Scouts in November, 1915, but was transferred to the Cameron Highlanders in August, 1916. Mr. F. Jones, the Marconi Superintendent at Cardiff, formerly of Glasgow, speaks of Phillips in high terms. It appears that Phillips answered the call for a volunteer to deliver an important message, and whilst carrying out this dangerous duty was killed by a shell. His commanding officer says of him: "He "was a fine soldier, and a real good comrade."

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules :* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions, readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (6) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

R. G. (Bizerta).—The production of continuous waves is dealt with in several books, but at present there does not exist any treatise devoted solely to the subject. With regard to the Poulsen system, fairly complete and up-to-date information is published in *Wireless Telegraphy and Telephony*, by W. H. Eccles, D.Sc., normally obtainable through our publishers, but at present out of print. We hope shortly to publish a volume dealing fully with continuous wave telegraphy, and an announcement will appear in our columns in due course.

V. E. A. (Derby).—(1) In the event of your failing to pass the Marconi Company's doctor, it is highly improbable that you would be able to obtain employment as a wireless telegraphist in the Mercantile Marine. Very few shipping companies employ their own operators, and we believe those who do so require them to pass an equivalent medical examination. There are no vacancies in shore stations in this country for men with no practical experience of wireless operating. (2) We have no special information on this subject, but have no reason to think that they differ from the ordinary examinations for the two services. (3) Students who obtain the Post-Master General's Certificate must enter employment as wireless telegraphists within fourteen days from the date of the certificate, otherwise the exemption lapses. Thank you for your good wishes.

H. W. L. (Broughty Ferry).—The diaphragm of a telephone receiver is set into motion by the magnetic attraction exerted by the magnet cores. Variations in the magnetism, caused by variation of the current in the magnet windings, cause sounds to be emitted by the diaphragm, the intensity of the sound varying with the intensity of the current charge. Let us assume that two stations are jamming one another on the same wavelength. Two sets of oscillatory currents, one superimposed upon the other, will be created in the receiving circuit, and these being rectified by the detector, will pass to the telephone windings where they will jointly act upon the diaphragm. If the two sets of signals were exactly equal in every particular, that is, exactly in phase, note, and of equal strength, then the resultant strength would be double that of either, seeing that the two superimposed currents would be pulling at the diaphragm at the same time. If the signals were not of the same note, and not equal, then you would get an effect analogous to the effect on the human ear when two notes on the piano are struck. If the signals happen to occur at the same time, then you get a double note. If not, then they are heard separately.

C. S. F. (France).—All the available information on this subject is published in the 1918 *Year Book of Wireless Telegraphy and Telephony* (see advertising pages). More than this we cannot give during the present restrictions.

A. M. S. (Mesopotamia).—We think that a lot of the trouble would vanish if you were to run a wire close to, and parallel with, the power line, for some little distance, and then earth the two ends. We should be interested to know if this remedies the matter.

A. C. (Glasgow).—Impossible to say, accurately, as requirements and conditions vary. Considerable practical experience as a telegraphist and as a wireless operator is usually called for. It is very rarely that a student straight from a school obtains such a post. We have never heard of it happening in this country. (2) Yes, if you can pass the Company's doctor. We know of several cases where discharged soldiers, or men rejected for the

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Army, have obtained positions on board ship. They are not very numerous, however.

J. H. (Anglesea).—(1) No one but an employee of the Marconi Company is entitled to wear the Marconi Company's uniform. We may mention here that, by a new Order in Council, wireless operators come within the regulations of the new Standard Uniform for the Mercantile Marine. As soon as one or two points regarding the braid are settled, we shall publish full particulars. (2) This is answered above. The fact that a man is taking a correspondence course is certainly no justification for wearing Marconi uniform.

C. W. (France).—(1) No, wireless telegraph operators not on naval articles are not entitled to wear service chevrons. (2) When vacancies offer themselves they are practically always filled from the ranks of the senior men. In view of the limited number of such appointments, it is not possible to find a shore position for every senior man. (3) No definite period. The answer to your second query will serve equally for this question. (4) Certainly, if he leaves with the Company's consent for this purpose, and he expresses a desire that his position shall be kept open.

T. G. (Bayswater).—We have not your previous letter by us at the moment. Experience shows that at least a couple of months' practical work is requisite, after completing a correspondence course, before a student is able to sit successfully for the P.M.G. Examination. Men who have a good knowledge of telegraphy sometimes get through in less time. As we have stated before, we cannot say what vacancies there are likely to be in the future. We are glad you find Penrose's book so useful.

L. L. N. (Peterborough).—Censorship restrictions, and the necessity of avoiding giving information to the enemy, prevent us dealing adequately with your queries. We can say, however, that a great deal of wireless telephone work is going on at the present time. We have had several communications similar to yours.

F. J. L. (London).—The forces of attraction and repulsion are equal and opposite in the cases to which you refer. In the case of the unlike poles adjacent as the poles approach each other, the force with which they attract one another increases considerably. Thus, when the distance between the poles is halved, the attraction is not doubled, but approximately quadrupled. In the case of the like poles adjacent, the repulsion does not show itself in such a marked manner as the attraction, seeing that the force of repulsion falls off so rapidly with increase of distance. In reply to your second question, the currents in C and D will be at a maximum at the same instant, but in opposite directions.

Share Market Report.

LONDON, October 11th, 1918.

The market in the various issues of the Marconi group has been very active during the past month, and all classes of shares show a considerable advance in prices. The prices as we go to press are:—Marconi Ordinary, £4 12s. 6d.; Marconi Preference, £3 15s.; Marconi International Marine, £3 10s.; Canadian Marconi, 15s.; American Marconi, £1 12s. 6d.; Spanish and General, 14s. 6d.

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SPECIAL NOTE.

THE MARCONI FREE TRAINING SCHEME IS NOW CLOSED.

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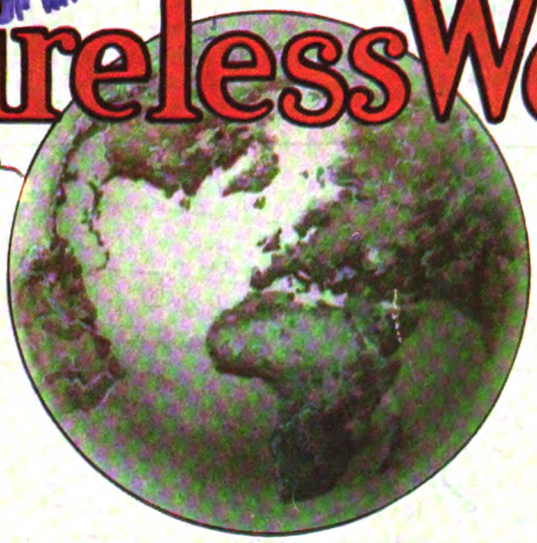

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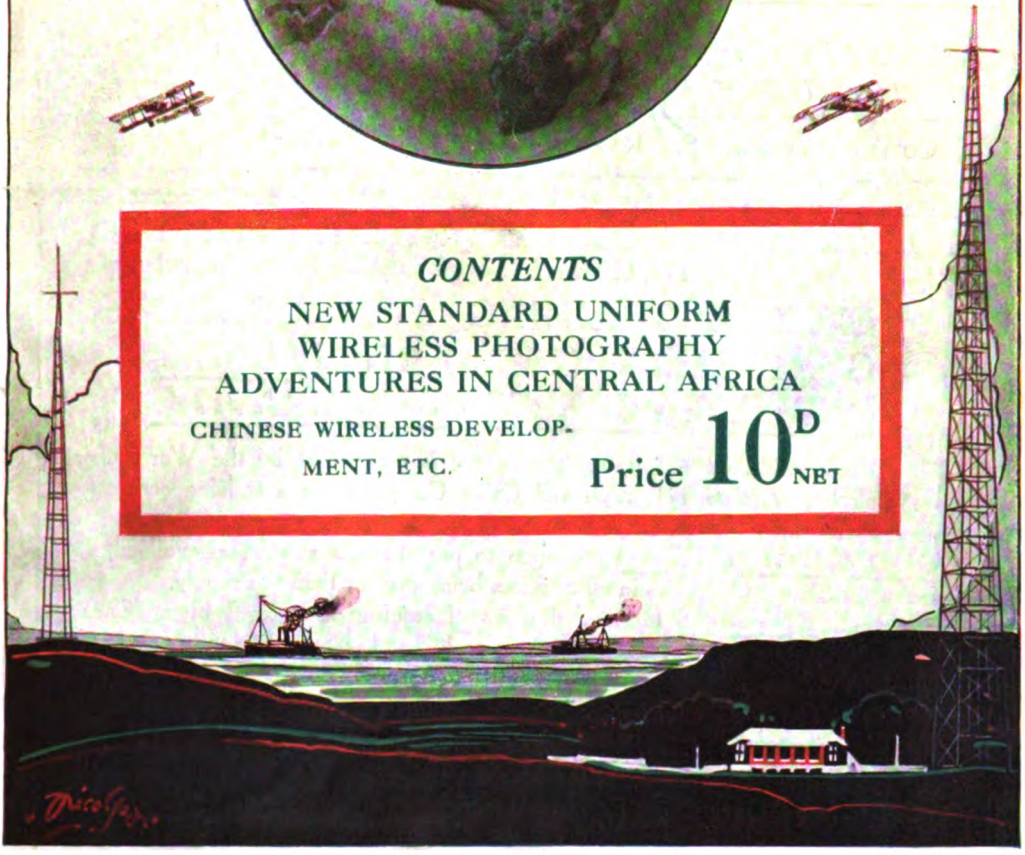

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Articles submitted for acceptance by the Editor (which will be paid for on publication) should be addressed to Marconi House, Strand, London, W.C. *No responsibility can be taken for MSS. or Photographs sent without stamps to defray cost of return postage.*

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The
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Volume VI. No. 69. DECEMBER, 1918.

Four Wireless Men in Central Africa

Notes of Our Wanderings in a Tropical Land

By LIEUT. E. F. BOILEAU, R.N.V.R.

We left Falmouth on January 11th, 1916, and on February 2nd reached Boma, a little town which lies where the Congo flows into the Atlantic Ocean, 6° south of the Equator. Here we reported to the Governor-General of the Belgian Congo and set to work to prepare for the long inland journey up that mighty river.

It took us forty-two days to reach Stanleyville, so named after Stanley, the famous explorer, whose black hair was turned to white by his sufferings in the course of opening up these districts to Western civilisation. Here we met Commander Spicer Simson, who was in charge of the expedition, and received instructions that all the material we brought with us should be despatched in charge of the warrant telegraphists on to Lake Tanganyika, whilst we remained behind for eighteen days to supervise the transhipment and facilitate the transport of the war stores then urgently required by the Naval African Expedition. From Stanleyville we proceeded

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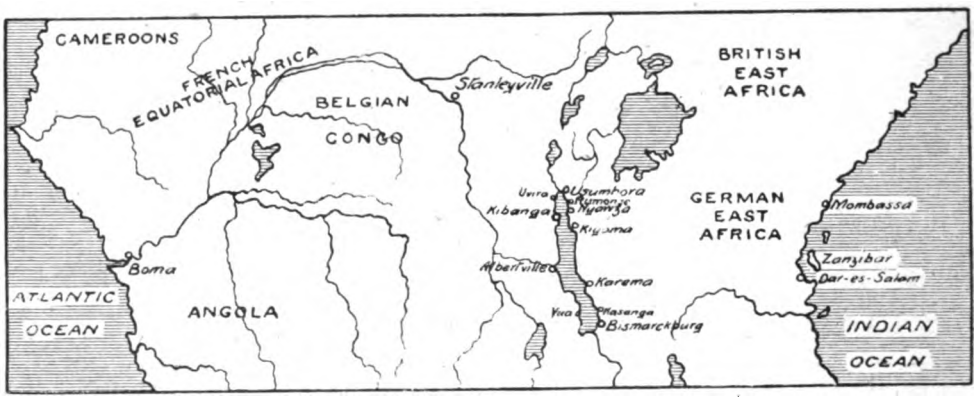
to Kalemio (now been renamed Albertville), which lies at the mouth of the Lukuga River, and at that time constituted the naval and military base for operations on the Lake. During the next fortnight we busied ourselves with overhauling and testing all our wireless gear, and found that the mechanical parts of the sets had suffered considerably on their journey from Stanleyville. This was due to the heavy condensation of moisture caused by the variation in temperature between night and day. It was not until May 15th that we became definitely attached to the Belgian Forces.



Our work consisted of the erection of stations at various points on the Belgian fringe of the Lake in conformity with the advance of the Allied Forces. We had to wrestle with any number of difficulties, mostly owing to the undeveloped state of the country. The loneliness, moreover, of white men—often working alone for long periods in the midst of natives—can only be understood by those who have gone through it. When we were sent, for example, to erect a station at Kibanga we found ourselves dumped upon an absolutely desolate spot on the sandy foreshore of the Lake, with no European neighbour nearer than half-an-hour's bush tramp away. We did not do so badly, under the circumstances, when we got this erection fixed up and wireless connection established within six days after starting.

One of our radiotelegraphic missions involved a journey by Lake steamer to Usumbora, a point the Belgian Forces had just occupied in their southern advance. As before, the soil was sandy, and so close to the Lake that, so soon as we started digging for our masts, we struck water. We did good service here, opening up communication *via* Kibanga with the base of operations 180 miles away.

Thus as the troops advanced they were kept in instantaneous touch with their base through a medium which possesses no wire exposed to the depredation of beasts, whether "wild" or human. The only protection necessary was that of guards of Belgian native soldiers, locally called Askari, in case the Germans might land raiding parties from their side of the Lake.

During July the military forces occupied Nyawza and we were ordered to erect at that point a portable set which had just arrived by the north-bound Lake steamer. This involved us in a most uncomfortable trip. Our transport was a long steel barge of the type commonly used for freight on the Congo rivers. Wireless men and gear were crammed on board, together with no fewer than 103 native carriers, all in ill-health, who were being sent back to their villages because they were unfit for further service with the troops. As officers, we lived, ate and slept in a most confined space on the forward part of the deck, and it was a happy day for us when we got quit of it.

The capture of Kigoma, the principal German port on the Lake and the terminus of the German East African Central Railway, created a new situation, and involved

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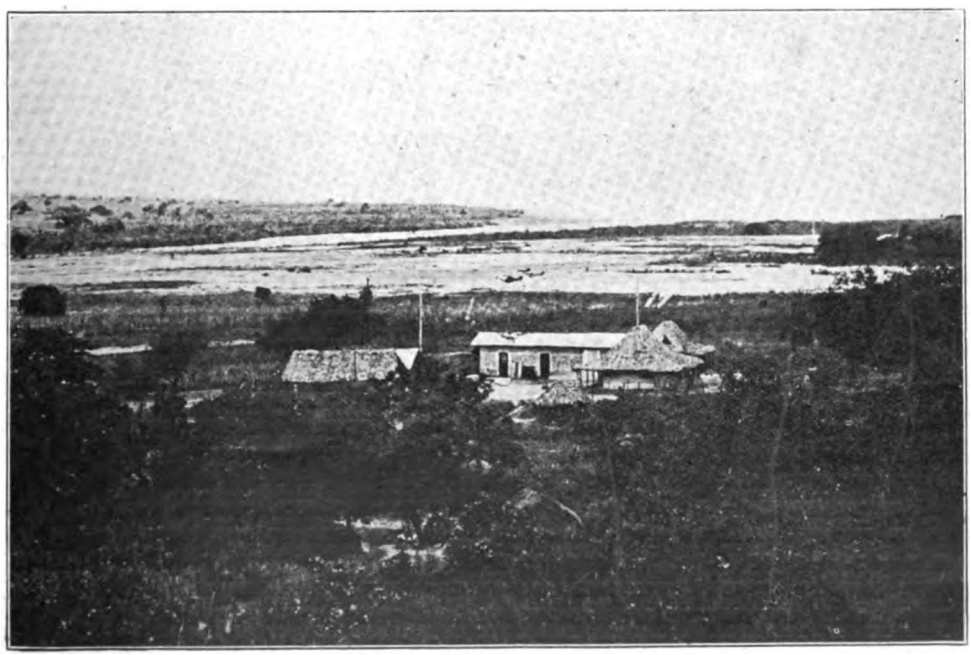
us in a sort of double-shuffling of stations. In such a country, where wireless constitutes the only means of rapid communication, and transport of material is so expensive, alike in time, labour, and cost, wireless gear is "worth its weight in gold," and it was of the utmost importance to put such material as was available on the spot to the best possible advantage. Owing to this factor in the situation, we were constantly obliged to dismantle installations only recently erected and shift them temporarily elsewhere, refitting when we were able. Thus, when we had to meet the wireless needs of Kigoma, scarcity of radiotelegraphic gear forced us once again to dismantle the Usumbora set and transfer to the erstwhile German Lake-centre both the 5 kw. set with which I was travelling and the 2 kw. gear which had been fixed at Usumbora. During the interval which elapsed between the dismantling, transference, and re-erection of these stations, the whole task of maintaining communication across the Lake between the General Headquarters of the Belgian Army in the field and the officer in charge of supplies and troops on the Lake, as well as the burden of linking up General Headquarters with the seat of government at Boma, was borne by the two British 1½ kw. sets. This interval lasted for a period of four weeks, at the end of which time the shuffling above referred to had fixed up Kigoma with the permanent installation, and released gear for Usumbora. To that wearisome spot therefore we once more wended our way on the river steamer.

In consequence of the imminent arrival of the rainy season we this time selected a site of fairly high ground, establishing our own quarters in a recently evacuated hospital. We had by this time become past masters in rapid erection! That set was therefore fixed up and put in operation between night and morning, and communication re-established with Kigoma, 100 miles away.

Now we made acquaintance with the troubles of working in the rainy season. During this period, traffic with the Belgian 2 kw. station at Kigoma was at times unreliable and always difficult owing to the prevalence of atmospheric disturbances,



BELGIAN WIRELESS STATION ON THE LUKUGA RIVER, THE ONLY STREAM THAT FLOWS OUT OF LAKE TANGANYIKA TO THE SEA.

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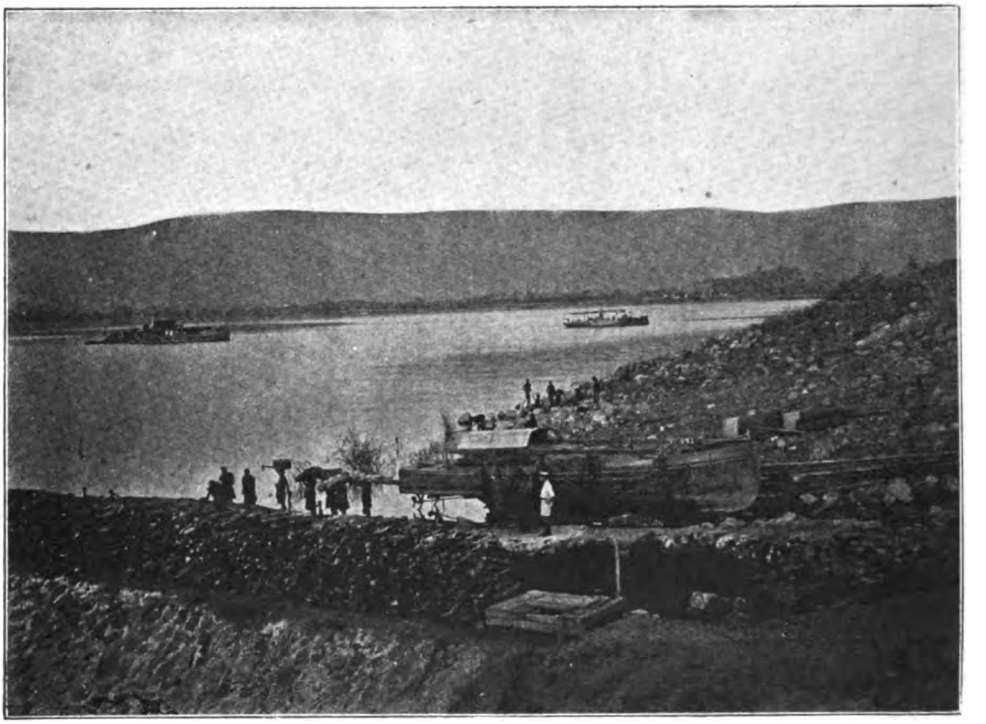

AT KASANGA ON LAKE TANGANYIKA: ONE OF OUR GUNBOATS PREPARING TO START.

These generally made their presence felt by obstructing signals at about 10 or 11 a.m. and putting a stoppage altogether on reliable working after midday. We therefore had to establish a relay station half way between the two.

I have already referred to the difficulties of wireless work in this part of the world; let me illustrate what we had to endure from delays in transport alone. Early in November the motor at Usumbora suffered from a bad "big-end" seizure, which bent the crank-shaft and the left-hand cylinder connecting rod. There were no spare parts available; those that I had cabled for in the previous May had not arrived, so we had to suspend *sending* altogether, only maintaining a receiving watch, and despatching messages by a fast runner, a distance of over 44 miles, to Rumonge (our half way station) for wireless transmission thence to Kigoma. It was not until December 9th that the long-expected spare parts, ordered seven months before, arrived. Even then I had to take the bent connecting rod down by river steamer to Kigoma and get it straightened; so that, what with one thing and another, it took me two months to put straight what could have been remedied at home in a day or two.

In March, 1917, during some fresh operations, the Belgian troops got down as far as Karema and, of course, "wireless" had to follow in their track. We came in here for a further period of hardship. The wet season was not yet over, and we were living in tents. When rain fell, which it did pretty profusely every day, we could get no food cooked because our "boys" had no kitchen, and could not keep the rain off their fire. We were, moreover, very short of food just then, the presence of a large number of troops having placed a severe strain on the supply of fresh food. The moisture in the atmosphere was so abundant that at night time you could squeeze it out of your mosquito net; whilst, to crown it all, the mosquitoes were

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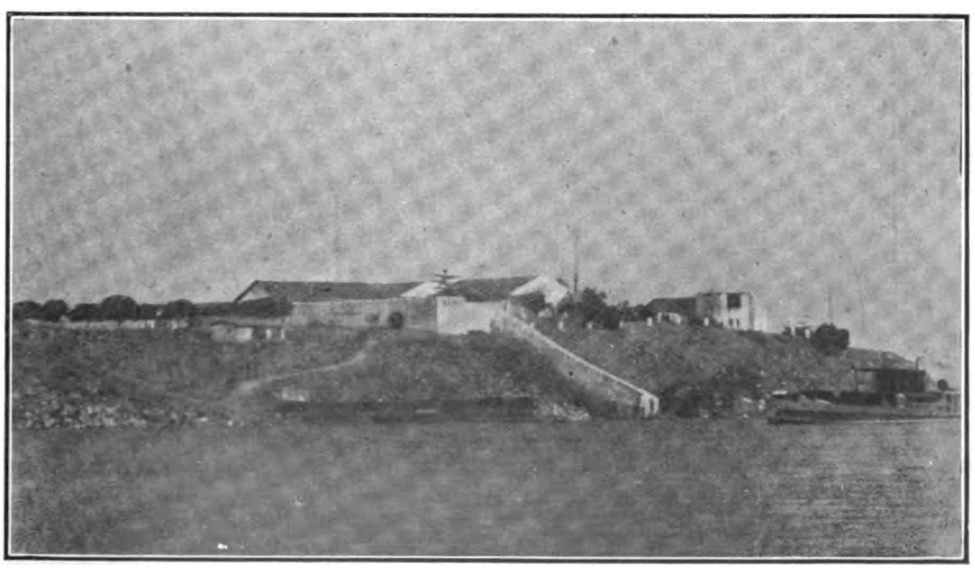
conducting a very effective campaign of their own. At times like these, it is none too easy to keep yourself fit and cheerful.

Still further south, we followed the victorious forces to Kasanga, then serving as a naval base for the British Tanganyika Flotilla. Here we set up a fresh station and soon established communication with the Belgian post of Vua, and with another 5 kw. set located at Kilope in the Belgian Congo. I was decidedly struck all through my wanderings with the high efficiency of the 5 kw. set in this part of Africa. The distance between Kasanga and Kilope was 112 miles, yet signals were quite good enough for traffic, although when we tried to extend our range as far as Karema, over a distance of 130 miles, we found our signals to be not sufficiently reliable, and were obliged to relay *via* Vua. One highly satisfactory feature of this Kasanga station consisted of an extraordinary absence of disturbance in the ether.

Soon after this Mr. Moore had to retire to the Kigoma Hospital through persistent attacks of fever ; and a little later (at the end of June to be more exact), there being no longer any fear of the Germans returning to the Lake, I received orders to dismantle the stations both at Kasanga and Karema, and proceed to Dodoma on the German East African Central Railway, whither by that time the base of the Belgian Colonial Army had been transferred.

This completed our Tanganyika service. We had worked on the shore of that Lake for fourteen months on end, enjoying a very moderate climate considering that we were but 3° south of the Equator, and experiencing very little sickness. The only illness of any importance was Mr. Moore's attack of fever referred to above. Of course, experience taught us many lessons ; but these lessons had to be bought often at the expense of severe labour and discomfort. We found the cart sets with which we had been supplied to be by no means the most convenient form of portable wireless that could be desired for this work. We constantly had to convey them across the Lake, and every time our installations were put on board it meant that the wheels had to be removed and each cart lifted by as many native labourers as could put their hands to it, into a steel lifeboat, well ballasted with mast gear. Then these lifeboats had to be paddled out to the steamer and the cart again lifted aboard from the small boats. This procedure was extremely awkward and sometimes risky.



KASANGA—THE NAVAL BASE FOR THE BRITISH TANGANYIKA FLOTILLA.

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PERSONALITIES IN THE WIRELESS WORLD

[*Photo, Elliott & Fry.*

DR. E. W. MARCHANT

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ELECTRICAL engineering has for over fifteen years figured prominently in the curriculum of the Liverpool University, and to Dr. E. W. Marchant must be assigned a full measure of the credit due. The late Mr. David Jardine bequeathed a gift of £10,000 to found a professorship, and Dr. Marchant was in 1903 elected to be the first occupant of the chair. The new laboratories were erected and equipped under his able supervision at a total cost of over £14,000. During recent years the generosity of Sir Wm. Hartley, J.P., has added a very complete installation for research work in wireless telegraphy.

Dr. Marchant was born in Kent during 1876, and educated first at University School, Hastings, and afterwards at the Central Technical College, Finsbury. At the latter establishment he won the Siemens Medal, and the Salomons Scholarship maintained by the Institution of Electrical Engineers. He graduated as B.Sc. at London University with honours in physics and mathematics, afterwards proceeding to acquire the degree of D.Sc. at the same university, together with a Granville Scholarship. After his apprenticeship he was (in 1897) appointed superintendent of Lord Blythswood's laboratories and workshops at Renfrew, N.B. At this time Mr. Marconi was demonstrating the value of his new discoveries, and fired the enthusiasm of our young electrical engineer, who set to work to investigate wireless on his own account. In 1900 he became Chief Assistant at the Finsbury Technical College, under the late Professor Silvanus P. Thompson, and in 1901 migrated to the University College, Liverpool, acting first as Lecturer in Electro-Technics, and subsequently accepting the post which he at present occupies. In the early stages of his career he became closely associated with the late Mr. Duddell in the development of the oscillograph, and was joint author of a paper read before the I.E.E. on the "Study of the Electric Arc by the Aid of Oscillographs." He has written many papers on wireless subjects, the more recent being contributions on the strength of wireless signals, read before the I.E.E. and the Wireless Society of London. He attended the International Wireless Commission at Brussels in 1914 as a British delegate, is a Vice-President of the Wireless Society of London, and Past President of the Liverpool Engineering Society. He is a Member of the Council of the Institution of Electrical Engineers, and Past Chairman of their Manchester Section.

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Some Aspects of Radio Telephony in Japan

By EITARO YOKOYAMA

(Engineer of the Ministry of Communication, Tokio, Japan)

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(Continued from page 435 of our November issue.)

Influence of Gap Clearance upon Discharge.

Descriptions have been given of the discharge phenomena, and the range of best pressure for the production of steady oscillations has been considered, but only in the case of a certain definite gap clearance—namely, 0·5 mm. To investigate the relation between the gap clearance and the corresponding most desirable pressure a series of tests were made, the gap clearance being varied from

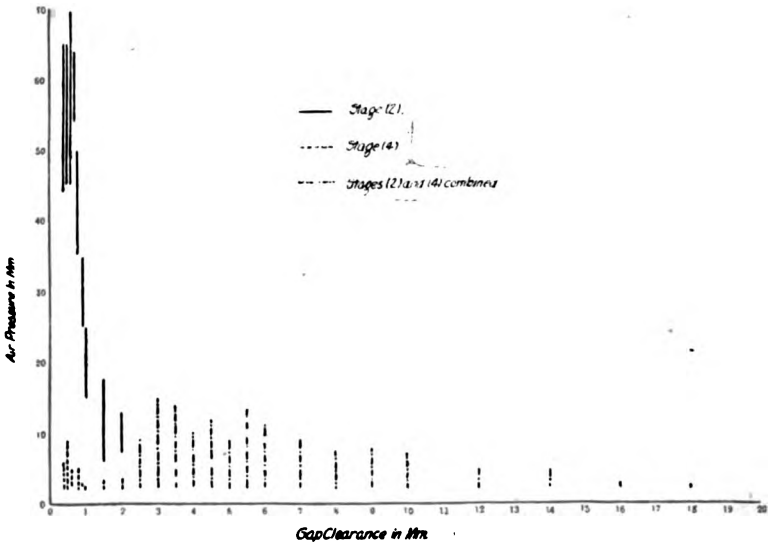

FIG. 9. RELATION BETWEEN GAP CLEARANCE AND MOST SUITABLE PRESSURE.

2 cm. (0·8 inch) down to 0·1 mm. (0·04 inch). The results of these tests are shown in Fig. 9. This figure shows that, in the case of short gap clearances, the useful range of air pressure is rather wide and extends to low vacua, while for longer gap clearances it is closely limited to higher vacua. Furthermore, there is no abrupt change between stages (2) and (4) for clearances longer than about 2 mm. (0·08 inch), stage (3) disappearing entirely.

To obtain data on the best operating conditions, the primary supply current, the terminal voltage at the gap, and the secondary oscillation current were simultaneously measured for various gap clearances with the corresponding most suitable

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air pressure, the supply voltage being kept constant. The results of the tests in stages (2) and (4) are shown respectively in Figs. 10 and 11. The data of the measurements for gap clearances longer than about 2 mm. (0·08 inch), (where the stages (2) and (4) cannot be differentiated), are all included in the curves of Fig. 11. These two series of curves show that the increase in gap clearance decreases both the primary supply current and the secondary oscillation current, and increases the gap terminal voltage. The conclusion is, therefore, that it is most advantageous to use as short as possible a gap clearance. However, it must be remembered that

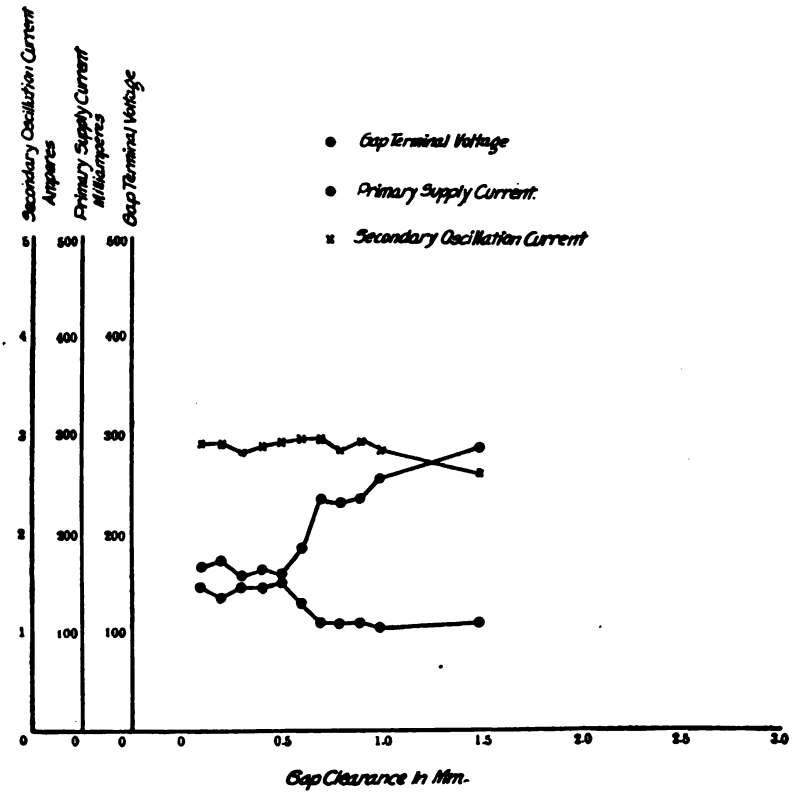

FIG. 10. RELATION BETWEEN GAP CLEARANCE AND SUPPLY CURRENT, GAP TERMINAL VOLTAGE, AND SECONDARY OSCILLATION CURRENT. STAGE 2.

there will be a lower limit to the shortest practical gap clearance because of other causes, such as heating of the electrodes which may melt them together in a very short gap.

INFLUENCE OF DIMENSIONS OF ELECTRODES ON DISCHARGE.

As stated, the time of continuance of discharge in the gap (and accordingly the duration of the secondary oscillation current) depends largely on the dimensions of the discharger electrodes. The dischargers of Figs. 2, 4, and 5 were compared in this connection, and the results are shown in Fig. 12.

With the discharger of Fig. 2 the discharge conditions in the gap became highly unfavourable and the secondary oscillations remarkably feeble after only some thirty seconds of operation. Using the discharger of Fig. 4 the time of continuance

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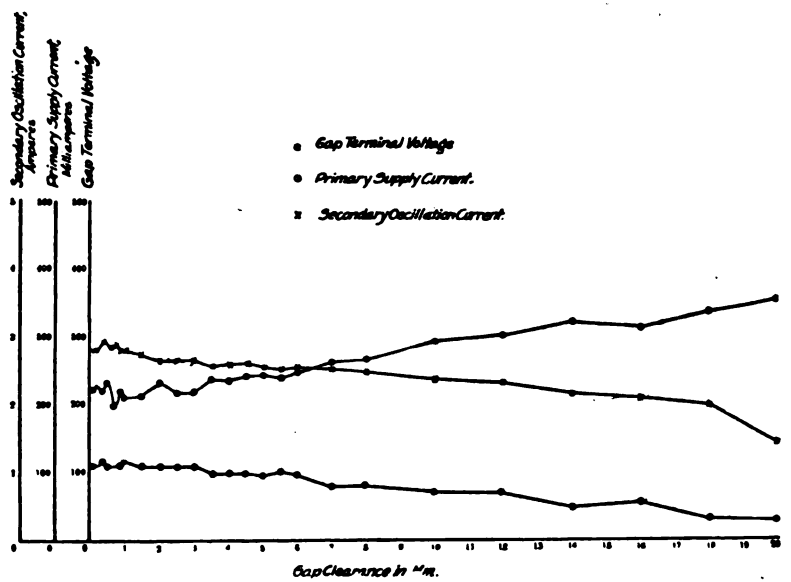

FIG. 11. RELATION BETWEEN GAP CLEARANCE AND SUPPLY CURRENT, GAP TERMINAL VOLTAGE, AND SECONDARY OSCILLATION CURRENT. STAGE 4.

of the discharge and of the secondary oscillations was, on the contrary, prolonged as long as some thirty minutes. With the discharge tube in Fig. 5 the operating condition of the discharger was still very good after two hours' continuous use.

As the supply voltage, the supply current, and the capacity of condensers, etc., were not exactly the same in each case shown by the curves of Fig. 12, the magnitude of the secondary oscillation current cannot be fairly compared from these curves. In addition, since sufficient precautions were not taken as regards the perfect sealing of the dischargers (these being made for temporary experimental use), the air pressure within probably changed in the course of the test. Otherwise the tube of Fig. 5 should have lasted far longer.

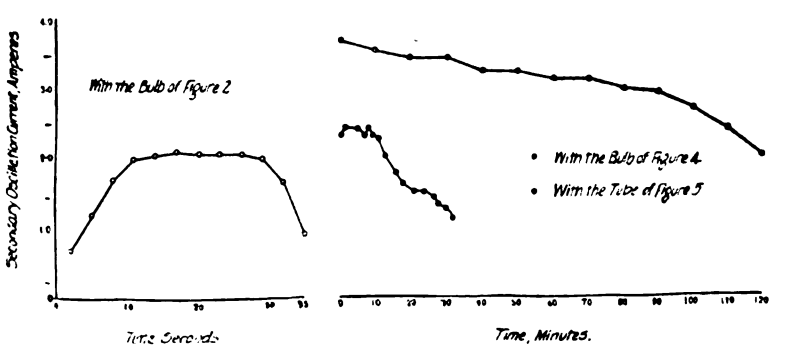
Secondary Oscillation Current, Amperes
With the Bulb of Figure 2
With the Bulb of Figure 4.
With the Tube of Figure 5
Time, Seconds.
Time, Minutes.

FIG. 12. EFFECT OF DIMENSIONS OF ELECTRODES ON TIME OF CONTINUANCE OF DISCHARGE.

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Influence of Shape of Electrodes on Discharge.

At first there were used electrodes of the form of Fig. 13 (*a*). It was found that the discharge was not very regular, and accordingly the oscillation produced not very steady. On attempting to use the electrodes having the form of Fig. 13 (*b*), which were exactly the same except with a pin-hole at the centre of their respective discharging surface, it was noticed that discharge and oscillation were remarkably improved. Comparing these two kinds of dischargers as the oscillation generator for radiophone work, the latter was found very satisfactory, while the former gave objectionable noise in the receiving telephone because of the irregularity of the discharge. It being evident that the shape of the electrodes had some influence on the nature and duration of the discharge, it was attempted to make a comparison using the four shapes of electrodes shown in Fig. 13, all possible combinations of the four kinds being tried. In the test, copper was used as anode and aluminium as cathode, the clearance between the electrodes being kept constant at 0·5 mm. (0·02 inch).

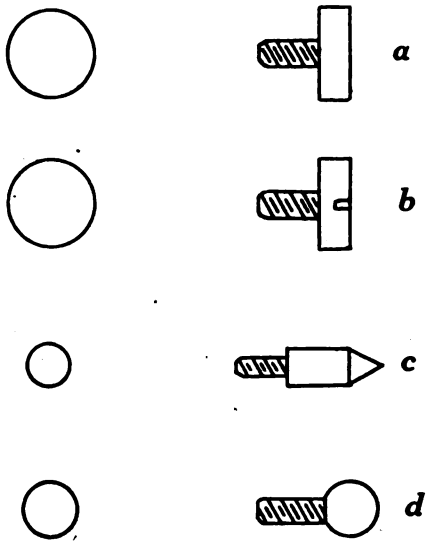

FIG. 13. VARIOUS FORMS OF ELECTRODES TESTED.

The best result was obtained by using the electrodes shown in Fig. 13 (*b*) for both terminals. The discharge was irregular with the electrodes Figs. 13 (*a*) or (*d*) as either one of the electrodes, this being due to the wandering of the discharge over the electrode surfaces. A discharger with (*c*) as either one of the electrodes also gave bad results in the long run, probably owing to excessive heating of the points.

(*To be continued.*)

Administrative Notes

The International Bureau of the Telegraphic Union at Berne notifies, under date of September 18th, 1918, in Circular Letter No. 71, as follows: "By letter "of July 12th, 1918, the Argentine Administration informs us that the coast station "Punta Delgada, Chubut, particulars of which station appear in the official list of "radiotelegraph stations with the endorsement, 'Under construction,' has now been "opened for general public correspondence."

The New Zealand Government recently opened a new wireless station at Rarotonga, in the Cook Islands. The whole of the apparatus therein installed was designed and manufactured by the Amalgamated Wireless (Australasia), Ltd., at their Sydney works. We hope to be able shortly to print views of this new development of wireless activity in the Pacific Ocean.

We learn from the Amalgamated Wireless (Australasia), Ltd., that they have recently opened a branch office at 422–424, Little Collins Street. The whole of the building has been taken over and the major part assigned as premises to the Marconi School. Mr. Horace Firth, who has been selected to direct the company's business in the colony of Victoria generally, has been appointed as superintendent of the Melbourne school.

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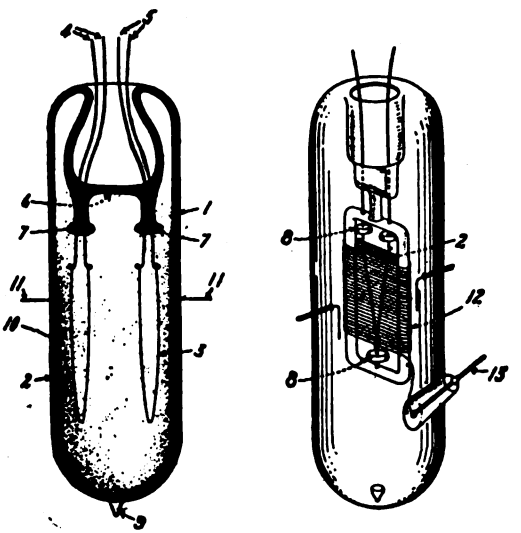
Digest of Wireless Literature

A Method of Constructing Gas-Free Electrodes.

In order to obtain the exceedingly high vacuum so essential in connection with the operation of the vacuum tubes, it is necessary that the metallic elements inserted in the envelope be gas-free.

Dr. Langmuir has recently shown a method whereby the anode of the vacuum tube consists of a coating of metal sprayed on the inside of the bulb by incandescing a refractory metallic conductor such as tungsten in a partial vacuum. To accomplish this the temperature must be sufficiently high to actively vapori e the refractory metal. This vaporised metal is deposited on the walls of the vacuum bulb as a hard, strongly adherent film, which even when so thin as to be transparent is a good electrical conductor, and capable of carrying relatively heavy currents. In fact, Langmuir has described a three-electrode vacuum tube in which an anode made in the foregoing manner was capable of receiving plate current of 100 milliamperes or more.



FIGS. 1 AND 2.

In the tube shown in Fig. 1 one of the filaments can be employed as the cathode of a two-electrode vacuum tube, and the other to supply the vaporised metal for casting the interior of the tube. The device then becomes a two-electrode valve, and can be employed as an oscillation detector or as an ordinary rectifier.

The tube shown in Fig. 2 is essentially a three-electrode vacuum tube. Dr. Langmuir mentions that it is not necessary to supply an extra filament to be vaporised, but that the main filament 2 can be made large enough so that part of its metal can be deposited on the inside of the bulb to act as the anode; in other words, the grid and filament of the vacuum tube are inserted during the original construction, but the metallic coating for the anode or plate is deposited by bringing the temperature of the filament up to a high degree of incandescence.

The process of manufacture is as follows:

Referring to Fig. 1, the envelope 1, consisting of glass quartz or similar non-conducting material, is provided with two vaporisable conductors 2, 3, consisting of tungsten tantalum or molybdenum, and provided respectively with leading-in

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conductors 4, 5, sealed into a stem 6 in the usual manner. One of these filaments 2, 3 may be used for the cathode of the completed apparatus and the other may be vaporised by heating it to incandescence by passage of current. The particles of vaporised metal travel outward in all directions in straight lines. In order to avoid the formation of a continuance conducting film over the entire inner surface of the container and in electrical contact with the cathode, provision should be made for intercepting the vaporised metal near the cathode so as to " cast shadows " on the envelope wall which will be free from deposited metal. This may be done by shaping the stem 6 so that it will in part bulge outwardly, also by providing knobs or rings on the leading-in wires as shown at 7, Fig. 1, or 8, Fig. 2.—(*Wireless Age.*)

THE REVOLVING MIRROR AND SPARK DISCHARGES.

Professor Lindley Pyle, Professor of Physics at Washington University, contributed to a recent issue of the *Electrical Experimenter* an article describing the revolving mirror method of observing and photographing the oscillatory nature of the " wireless " spark. Fig. 3 shows, diagrammatically, the apparatus used. A small transformer, *T*, is used to charge the capacity, *C*, which is so arranged that it will discharge through the inductance, *L*, and across the spark gap, *S*. This discharger consists of two zinc rods thrust through poles bored in the side of a wooden box, the box completely enclosing the spark except at one side, where a hole is cut. The box may be about 6 in. long and the gap about $\frac{1}{8}$ in. Light from the spark passes out through the hole in the box, thence through the lens, *L*, to the mirror, *M*, whence it is reflected back through the lens to a focus at *P*, which is either a photographic plate or a piece of white card. The mirror is fastened upon the projecting shaft of a small high speed motor and, being silvered on both sides, is really equivalent to two mirrors.

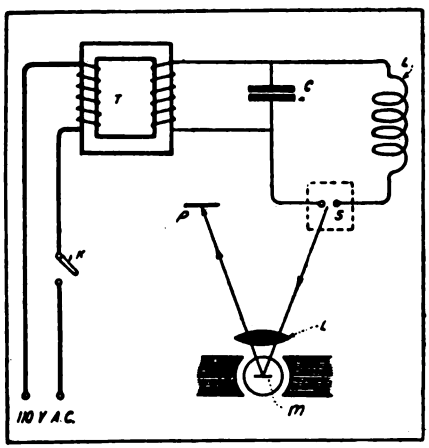

FIG. 3.

With the spark discharge in action and the motor at rest, a bright and sharp image of the spark will be seen upon *P*, provided, of course, that the mirror is set at the correct angle. If now the shaft of the motor is rotated slowly, while the spark is occurring, a number of separate images of spark discharges will appear upon the white card or plate. Each separate image corresponds to a complete spark of the discharge. The faster the mirror is rotated the wider will be the separation between these bright images.

Let us now switch on the current in the motor circuit. As the motor attains a high speed the spark images will be very widely separated and soon a point will be reached when there will be only one image on the card at a time. This image will then be seen to be " dragged out " and will itself resolve into a number of separate images, one for each passage of current across the gap, or two for each complete oscillation. The first of the series will be the brightest, and each subsequent image will be diminished in intensity, the total number of images in the complete train being, of course, dependent upon the damping of the circuit. It is obviously a simple matter to calculate the oscillation frequency of the circuit from the separation between the images and the speed of the motor.

The article describes in detail how the apparatus used may be manufactured, and

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a photographic reproduction is given of an oscillatory spark discharge taken with the apparatus described. Although it is not mentioned by Professor Pyle, the spark-gap, *S*, in Fig. 2 should be so arranged that the electrodes are above one another, and not side by side as shown.

WIRELESS ON TRAINS.

The paper is a *résumé* of research work carried out by the writer from 1906-1916 for the Union Pacific Railroad Company.

It was at first attempted to actuate signals in the cab of a locomotive by using a coherer, but it was found that the reliability was insufficient. It was therefore decided to experiment as to the best means of obtaining communication with moving trains, either by wireless telegraphy or by wireless telephony. The various types of antennæ tried both on the trains and for the land stations alongside the line are described, explaining the difficulties incidental to railway work. It was found that a flat-topped antenna with ground counterpoise gave the best results. Considerable work was done with radio-telephones, which is illustrated and described. There are diagrams of the connections and a plan of a train, showing some particulars of the wireless installation.

A dining-car was converted into a wireless laboratory and there are photographs showing the wireless apparatus installed.—(Dr. Frederick H. Millener, *Proceedings of the Institute of Radio Engineers*, August, 1918.)

WIRELESS COMMUNICATION BETWEEN HOLLAND AND THE DUTCH EAST INDIES.

The *Allgemeen Handelsblad* is informed by an Apeldoorn correspondent that it is proposed to erect the Dutch station for wireless communication with the Dutch East Indies at Hoog-Buurloo, near Apeldoorn. A railway a few miles long will have to be constructed from that place to Kootwijk for the transport of construction materials and to provide easy access to the wireless station when it has been erected. There will be four receiving towers, with an electric plant having an immense capacity, greater than that of any other in the country. Extensive buildings will be erected, including dwellings for workmen. The wireless station will be placed upon the Koelberg (between Hoog-Buurloo and the railway line), which is 86 metres high, one of the highest points in Holland.

The Telefunken Company of Berlin has been asked to send an engineer to inspect the ground selected. The wireless station will be of about the same extent as the immense wireless station at Nauen and direct communication will be guaranteed with the similar station to be erected in the Dutch East Indies.—(*Allgemeen Handelsblad*, August 11th and 18th, 1918.)

IMPROVEMENT IN DIRECTIVE WIRELESS TELEGRAPHY.

French Patent No. 485,632 of A. Artom is concerned with the use of multiple directive antennæ for sending or receiving. The antenna consists of several aerial wires connected to different plates of a condenser situated in the oscillating circuit or to different tappings of an inductance situated in the oscillating circuit. Each aerial wire consists of a pair of conductors so placed as to facilitate the radiation or reception in one direction. The entire system may be tuned to a single frequency, or each pair of conductors may be tuned to a different frequency.—(*Revue Générale de l'Electricité*, September 28th, 1918.)

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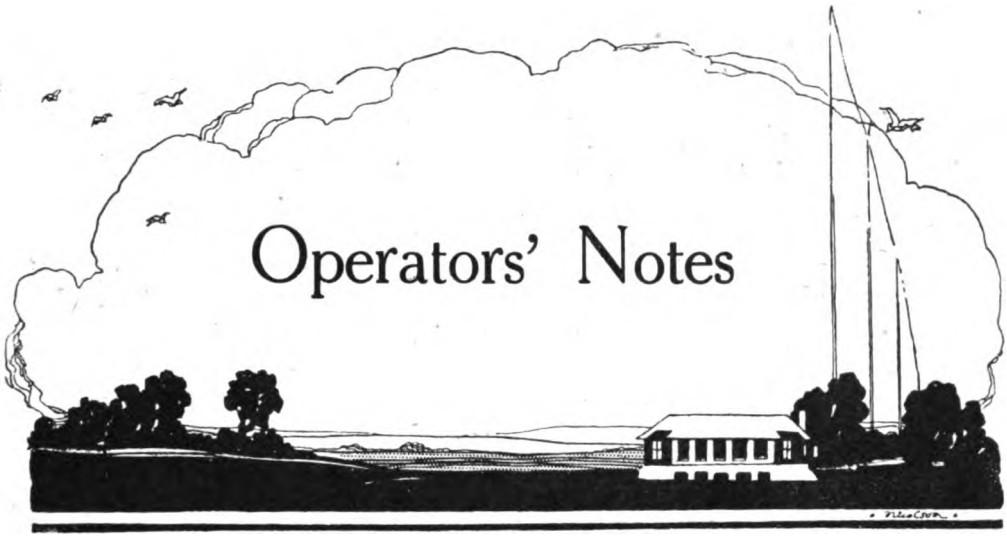

The New Standard Uniform for the Mercantile Marine.

In our October issue (page 400) we made a preliminary announcement regarding the new standard uniform in the British Mercantile Marine, which has now been approved by His Majesty the King. Although the Order-in-Council containing particulars of the new uniform was issued in September, detailed particulars of the exact manner in which the wireless operator's braid was to be worn have only just been received from the Board of Trade.

The regulations for the standard uniform are lengthy and detailed and many of them, of course, do not apply to wireless men. The following extracts, however, contain the whole of the regulations which actually apply to wireless operators:

"(1) The uniform of the British Mercantile Marine shall be such as is set forth "in the Schedule to this Order: Provided that where at the date when this Order "comes into operation the Masters and Officers of the ships belonging to any company "or firm are accustomed to use a cap with a distinctive badge, that badge may, if "the company or firm so desire, be substituted, in the case of persons whilst serving "on board or employed on the business of ships belonging to that company or firm, "for the cap badge prescribed in the said Schedule.

"(2) The persons entitled to wear the uniform so prescribed shall be Masters "and Officers of the Mercantile Marine holding certificates from the Board of Trade. "Uncertificated Junior Officers of the Mercantile Marine qualifying for their first "certificate, and Surgeons, Pursers, Wireless Operators, Cadets and Apprentices of "the Mercantile Marine, and Petty Officers and other ratings of the Mercantile "Marine specifically mentioned in the said Schedule, but no other person whatsoever.

"(3) The uniform to be worn by any person whilst employed in any position or "rank on board any ship shall be the uniform appropriate to that position or rank, "without reference to the class of certificate which he may hold.

"(4) A member of the Mercantile Marine employed ashore, or temporarily "unemployed, shall be entitled to wear the uniform appropriate to the highest rank "in which he has at any time been previously employed.

"(5) No person entitled to wear the uniform shall, when on board ship, in port "or on shore, be dressed partly in uniform and partly not in uniform.

"(6) This Order shall apply only as respects persons who are or who have been "employed on British ships registered at ports in the British Islands.

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" (7) This Order shall come into operation on the day of the promulgation " thereof.

" (8) This Order may be cited as 'The Mercantile Marine (Uniform) Order, " '1918.'

" EXTRACT FROM SCHEDULE.

" 1. DISTINCTION LACE OR RANK STRIPES.

" *First Wireless Operator.*

" 2 waved lines, with diamond, of ¼ in. gold Russia braid (or black braid).

" The space between each row of braid is to be 1½ in.

" First Wireless Operators (will wear) one diamond of ¼ in. gold Russia " braid (or black braid), with open centre, and an outside measurement (angle to " angle) of 1½ in. imposed on the distinction lace (see illustration, page 494).

" *Second Wireless Operator.*

" 2 waved lines of ¼ in. gold Russia braid (or black braid).

" *Third Wireless Operator.*

" 1 waved line of ¼ in. gold Russia braid (or black braid).

" 2. GREAT COAT.

" For all Officers, but not Cadets or Apprentices. Blue cloth. Length to come " to 14 in. from the ground. Double breasted. Six buttons on each side, to button " four buttons, the bottom button not to come below the level of hips. A plait " down the back, with an opening at the bottom 18 in. long with a fly and three " small plain buttons. A cloth strap behind with a buttonhole at each end and " two corresponding uniform buttons to confine the waist to required size. Stand " and fall collar with hook and eye in collar seam. Edges of coat to be double " stitched, the shoulders fitted with straps for rank stripes.

" 3. FROCK COAT.

" For all Officers, but not Cadets or Apprentices. Blue cloth, double breasted, " with padded turn-down collar. Cut for six buttons, but to have five buttons on " each breast, to button four buttons, the width of lapel to be 3 in. at fourth button, " tapering to 2¼ in. at waist seam; two buttons on the hips, with side edges in " plait of skirt extending halfway down the skirt, with a button at bottom of each " side edge. For Officers, 5 ft. 9 in. in height, length of coat 38 in., with a propor- " tionate variation for difference in height. The proportionate variation in length " of skirt for each inch of difference in height is ¼ in. Lining, black material. " Round cuffs, and rank stripes on the sleeves. A black morocco leather belt, 1½ in. " wide, with gilt buckles of same design as standard cap badge can be worn optionally.

" 4. UNDRESS COAT.

" For all Officers, Cadets and Apprentices. Blue cloth, with padded turn-down " collar, the length to be sufficient to cover the hips; double breasted, with five " buttons at equal distance on each side, to button four buttons. Pockets without " flaps at the sides, in line with the lower button, and one outside left breast pocket. " An opening 5 in. long at the bottom of each side seam. Round cuffs, rank stripes " on the sleeves.

" 5. WORKING UNDRESS JACKET.

" Blue serge, single breasted, stand collar, with hook and eye at neck, five " buttons at the front, and opening at bottom of each side seam 5 in. long. A " patched pocket on each breast without flaps. Shoulder straps for rank stripes " in black mohair.

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"6. WHITE UNDRESS COAT.

"White drill, single breasted, stand collar, with hook and eye at neck, five "buttons at the front, and an opening at bottom of each side seam 5 in. long. A "patched pocket on each breast, without flaps. Shoulder straps for rank stripes.

"7. MESS JACKET.

"Blue cloth, double breasted, six buttonholes in each row, four on the turn "and two below, padded turn-down collar; slightly roached over the hips with a "rounded peak behind; two pockets with welts at the sides. Round cuffs, with rank "stripes.

"8. WHITE MESS JACKET.

"White linen, of the same shape as the blue jacket but with a roll collar, two "buttons in each row, and two buttonholes on either side to correspond with the "buttons, to be worn linked with two No. 2 size buttons connected by a ring. "Shoulders fitted with straps for rank stripes.

"9. SHOULDER STRAPS.

"For all Officers, but not Cadets or Apprentices. Blue cloth with rank stripes "and coloured cloth, according to rank or branch. Straps to be 5 in. long, 2¼ in. "wide, and to have a No. 3 button on top.

"10. TROUSERS.

"Blue cloth, but no gold lace, for frock or undress coat. Blue serge for working "jacket, and white duck or drill material for white undress coat.

"11. WAISTCOAT.

"Blue cloth, single breasted, with six buttons. For wear with blue mess "jacket: Blue cloth, single breasted, cut low, with roll collar and four buttons. "For wear with white jacket: White marcella, the same pattern as the blue waist-"coat.

"12. BUTTONS.

"A gilt-raised round button, with a plain rim encircling a rope rim, surrounding "an anchor without cable rove through a naval crown. (Registered Design "No. 664,376.)

"(1) Eight-tenths of an inch in diameter (or, in button-maker's measure, "35 lines, relief 7 lines).

"(2) Fifteen-twentieths of an inch in diameter (or, in button-maker's measure, "30 lines, relief 6 lines).

"(3) Thirteen-twentieths of an inch in diameter (or, in button-maker's measure, "25 lines, relief 5½ lines).

"They are to be worn as follows:—

"Size No. 1 on all coats. Size No. 2 on jackets. Size No. 3 on waistcoat and "shoulder straps.

"13. CAP AND COVER.

"For all Officers, Cadets and Apprentices. Cap: Blue cloth, with three blue "cloth welts, 3¼ in. total depth, diameter across the top 8¼ in., for a cap fitting "21⅜ in. in circumference, the top to be ⅛ in. larger or smaller in diameter for every "¼ in. the cap may vary in size of head above or below the before-mentioned standard "—*i.e.*, a cap 22¼ in. in circumference, diameter across the top 8½ in.; cap 21 in. "in circumference, diameter 7⅞ in. The sides to be made in four pieces and to be "1½ in. deep between the welts; a black mohair braid band, 1½ in. wide, placed "between the two lower welts, the join of the band to be in front so as to be covered

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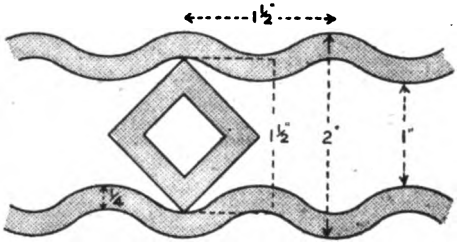

RANK STRIPES: FIRST WIRELESS OPERATOR.

" by the badge, the upper side of the " mohair band to be left unsewn to admit " of bottom edge of white cover being " slipped under when required.

" The cap set up on a band of stiff " leather or other material 1¾ in. deep.

" The use of steel cap stretchers is " prohibited.

" Cover: The cap cover to be of " white ribbed marcella.

" Peak—For Masters: Covered with " blue cloth and bound with patent " leather, and embroidered on the front " edge with laurel leaves in gold ½ in. wide.

" For all other Officers, Cadets and Apprentices: Patent leather without " embroidery.

" The peak to drop at an angle of 45 degrees and to be 2 in. deep in the middle " when worn with embroidery, and 1¾ in. when plain.

" Chin stay for all Officers, Cadets and Apprentices: Black patent leather, ⅜ in. " wide, buttoned on to two black cloth " buttons placed immediately behind the " corners of the peak.

" 14. CAP BADGE.

" Gold naval crown over silver anchor " (without cable), the anchor on red oval " cushion with gold rope rim, surrounded " below and at the sides by gold oak- " leaves and acorns. The whole on a " backing of navy blue cloth (Registered " Design No. 664,377).

RANK STRIPES: SECOND WIRELESS OPERATOR.

" 15. FOUL WEATHER COAT AND HAT.

" A black oilskin and sou'-wester of the usual pattern.

" 16. NECKTIES AND COMFORTERS.

" Neckties: With frock-coats or undress, a plain black silk or satin tie, 1½ to " 2 in. wide.

" With mess undress, a plain black silk or satin tie, 1 in. wide.

" Comforter: To be white.

" 17. GLOVES.

" Plain, brown dogskin, or brown buckskin, with greatcoat, undress coat and " working undress jacket.

" Plain, white, with frock-coat and mess jacket.

" 18. BOOTS.

" Black boots or shoes with all uniforms other than white undress, with which " white shoes may be worn."

RANK STRIPE: THIRD WIRELESS OPERATOR.

As soon as the Order was issued the Board of Trade was approached and asked to state:

(1) Whether the crests of the waves in the upper row of lace were to come

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immediately above the crests of the lower row, or whether the crests of the upper row were to be above the troughs of the waves of the lower row.

(2) If the latter, whether the space of 1½ in. was to be measured at the maximum or minimum separation.

(3) Whether the diamond was to be placed at a point of maximum or of minimum separation.

(4) What was to be the measurement from crest to crest of the waves.

The Marconi Company has now received from the Board of Trade a drawing giving an explanation of the points above and with the correct measurements marked thereon. This drawing is reproduced herewith.

It should be particularly noted that it is a punishable offence for any unauthorised person to wear this standard uniform. Students, whether attached to Marconi or private schools, who have not been to sea as wireless operators are not entitled to wear this uniform and are liable to incur serious penalties by so doing. The present Marconi uniform, with the " M " badge and buttons and crossed wave braid, thus becomes obsolete, although, of course, those members of the staff who already possess such a uniform will be able to effect the change at a cost considerably less than that of a complete uniform by changing the badge, buttons and braid. This should be done as soon as possible.

[Official photograph

A GERMAN METHOD OF GENERATING POWER FOR TRENCH WIRELESS.

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Telegraphy, Aeronautics and War

In the book now before us* Mr. Bright has collected together a large number of his addresses, papers and memoranda on the three subjects of telegraphy, aeronautics and the war, the first of these subjects preponderating. Several of the author's contributions are of great value as presenting to the general reader the importance of inter-Imperial telegraphy in a clear and interesting manner. In many parts of the book a comparison is made between the cable method of communication and its younger sister radiotelegraphy. Almost invariably Mr. Bright arrives at the conclusion that the cable method is considerably the better.

We, for our part, would be the last to claim that wireless telegraphy has yet reached perfection, or that there do not exist a number of problems which cry for solution. At the same time it is quite wrong to imply that cable telegraphy is a perfect means of communication, and an impartial enquirer will find that cable telegraphy is faced with a number of problems every whit as difficult as those which at present face the newer art, besides possessing certain insuperable objections unknown to wireless telegraphy.

As a Fellow of the Institute of Radio Engineers, and a Delegate at the International Radio Telegraphic Conference of 1912, Mr. Bright is singularly ill-informed in his radiotelegraphic facts. Indeed, many of his conclusions rest upon erroneous assumptions and totally unsubstantiated statements. Not that the author sets out to be an open opponent of wireless telegraphy—indeed he goes so far as to point out its many advantages for certain classes of work.

One of the earliest statements which will cause surprise among those acquainted with practical radiotelegraphy occurs in the introduction, where the author is speaking of transatlantic wireless. "A very good route in some ways for a transatlantic "wireless system would be by the Faröe Islands, Iceland, Greenland and Labrador, "with a terminus at each extremity in more or less close proximity to the trans-"atlantic cable terminus. One advantage of such a route would be that, on account "of its distance from the shipping route, it is less likely to be a source of disturbance "to ordinary marine 'wireless' work. Again, owing to the series of comparatively "short subdivided sections herein provided, the power required would be far less, "and therefore free from the objection of disturbing the multitudinous 'wireless' "that goes on between ships in ordinary transatlantic routes." Quite apart from the fact that it can be definitely stated that the Marconi transatlantic stations *cannot be heard* by ordinary ship installations, even at close quarters, unless special apparatus is provided—a fact which any seagoing operators would have given to Mr. Bright on request—such a duplication of stations would mean four repetitions for any one message which crosses the Atlantic. Every wireless station which keeps up a constant service needs to have power in excess of that required to cover the distance to which it communicates in favourable circumstances, and if such long wave stations interfere with ship working—which they do not—then we fail to see how matters would be remedied by four or five times the amount of signalling for the same traffic. This paragraph, however, is typical of many based upon erroneous assumptions.

A few lines farther down we come upon a statement that the German wireless station at Nauen has "A constant station transmitting power of 6,000 miles occa-"sionally raised to 7,200." The Nauen Station, even since its power has been considerably augmented, has never had a constant range of anything approaching this, and frequently has great difficulty in covering half that distance.

* *Telegraphy, Aeronautics and War*, by Charles Bright, F.R.S.E. London: Constable & Co., Ltd. 16s. net.

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When the European War broke out, very few days elapsed before the world at large became acquainted with the extreme vulnerability of the cable, the British Forces severing every one of the German lines to America. It is rather amusing, therefore, to find Mr. Bright speaking of the vulnerability of wireless antennæ. The footnote on page 54 states: "The range of an up-to-date naval gun is often "greater than the distance at which a wireless station can be readily accommodated "inshore." Surely Mr. Bright cannot have forgotten the case of Nauen, which he mentions a few pages before; of the Eiffel Tower, to which he makes frequent reference; not to mention Arlington (now called Washington), Hanover, Lyons, and Madrid, all of which are referred to in the book.

In fairness to Mr. Bright, it should be mentioned that many of the papers reprinted in this volume were published before the outbreak of war. One statement, however, is repeated so extensively, in papers delivered before and after the war, that we feel we cannot omit reference to it. It is to the effect that the wireless system does not lend itself to code to the same extent that prevails with cables. This statement is completely disproved by the war experiences of all belligerent nations—most dramatically, perhaps, by the machinations of Count Bernstorff, as evidenced in the Sayville wireless disclosures.

In an address delivered by Mr. Bright at the end of 1911 he made the statement that "An untuned radio system, like that on the Eiffel Tower, is capable of com-"pletely demoralising all other radiotelegraphy that is proceeding within, say, a "range of 1,000 miles." A similar statement was repeated in the *Empire Review* about the same time. This statement appears in several places, being modified at a later date into "such as that *at one time* on the Eiffel Tower." The italics are ours. Although the earlier installation on the Eiffel Tower was a slow spark highly damped system, impossible to be tuned out *sharply*, yet at its worst it never interfered with ordinary ships' traffic, seeing that its wavelength (2,500 metres) was more than four times that used for ship and shore communication. It is necessary to emphasise this point, as the impression is given throughout Mr. Bright's volume that high power stations, *whatever their wavelength*, interfere with ordinary ship and shore communication.

On page 112, where a rather laborious attempt is being made to belittle long distance work by wireless, and to eulogise the cable working, the author says, "The "difference between the two is akin to that between an express and a suburban "train whose constant stops correspond to the retransmission necessary with "radiotelegraphy, but overcome, in the modern cable service, by an automatic "relay. Thus the whole world can be encompassed by cable in a quarter of an hour. "How long would that take by wireless?" The answer to this difficult question is, about a quarter of a minute—as Mr. Bright will find, if he refers to recent newspaper reports of direct wireless communication between Great Britain and Australia, where the messages despatched by wireless and cable at the same time arrived by wireless very much in advance.

On page 257, in a reprint of a memorandum supplied to the Dominions Royal Commission as late as July 29th, 1914, Mr. Bright says, speaking of errors in cable and wireless work respectively, "I consider on the contrary that as 'wireless' "usually involves in practice the reception of Morse signals on a telephone, the "wonder is that more errors are not made by the operators, having regard to the "slight difference between a dot and dash—between, say, the signification for the "letter 'A' and the letter 'M.'" It should not be necessary to point out the fallacious reasoning contained in this paragraph. We would remind the author that the difference between a dot and a dash is exactly the same in the telephone as on the telegraph sounder. Reception is aural in each case, and seeing that the "sounder" is largely used by cable companies between their sub-offices and the cable station, this argument must prove to be a two-edged weapon.

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Wireless Telegraphy In the War

THE VICTORY MESSAGE.

THE war, and therefore "Wireless in the War," is over. Our heading made its first appearance in September, 1914, and we print it here for the last time. Wireless has "done its bit" in the struggle and shares in the triumph. We have endeavoured to record in the pages devoted to this section such of the achievements of radiotelegraphy, and the incidents connected therewith, as censorship has permitted. Over and over again we have been obliged, in the public interests, to be silent; and just as the world must learn in the coming peace-time the most brilliant of the feats of their fighting men, so must it await the abolition of censorship before it can be told the most striking achievements of wireless.

We just now used the phrase in connection with radiotelegraphy that it "had "done its bit," and did so advisedly, in view of the fact that this expression has become honoured amongst us through what it typifies. But we should be fully justified were we to revert to the more full-mouthed declaration, put by Virgil in the mouth of Æneas—"*Quorum pars magna fui*" ("Wherein I played a mighty part").

The wireless message of the German Government to their merchant ships bidding them fly to the protection of the nearest port, for fear of the British Fleet, marked the initiation of the world struggle. This message was despatched before the actual declaration of war by England.

A wireless announcement of the signing of the armistice—that acknowledgment of utter defeat by the Powers of Evil as embodied in German militarism—consummated its close.

The following brief *résumé* will indicate how that armistice was, from start to finish, shepherded by wireless telegraphy:

On Thursday, November 7th, the German authorities sent out from their wireless stations an acknowledgment of President Wilson's pronouncement that Marshal Foch was "empowered to receive accredited representatives of the German "Government and to communicate the armistice conditions to them." The same message included the list of the German representatives, and asked that the plenipotentiaries should "be informed by wireless where they can meet Marshal Foch," adding, with their characteristic effrontery, a petition for provisional cessation of fighting "in the interests of humanity." French wireless took up the tale, and Marshal Foch instructed the enemy delegates what route they must follow, in order to reach him and learn the offer he was prepared to make. On Friday, November 8th, the German plenipotentiaries radiated through French Government stations the message that they had "received the conditions of the armistice as well as the

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" formal demand that they should be accepted or refused within seventy-two hours," adding that all their attempts to shuffle were unavailing, and there was no need to send fresh delegates. Through the same medium the enemy emissaries advised their Government of the departure and route of the envoys who bore the historic document to its *destinataires*.

On Monday morning, November 11th, came the " Crowning Mercy " in this solemn series of wireless inter-communications. It fell to the lot of operators, as they maintained their listening watch during the chill small hours, to receive the momentous message from the French Marshal announcing that the armistice had been signed. The phrase " A message of Fate " has often been employed; surely never before has its employment been so completely justified. The whole world was waiting expectant. And ether waves placed the whole world in a position to learn the news at once and simultaneously. The armistice was signed at 5 a.m. Wireless brought the intelligence to London at 5.40 a.m., and—seeing that these waves travelled with a speed of light—we may take it that its reception everywhere occurred practically at the same moment. What a drama! And what a *dénouement!*

AND ITS PRICE.

The old phrase " No Cross, no Crown " has been true throughout the world's history, and it is true to-day. Heavily has the Cross weighed upon us during the four years and three months of the war's duration. Too many of those who have had to bear it are no longer with us to wear the Crown. The memory of the men who have made the supreme sacrifice deepens the solemnity of the hour, and sobers

WIRELESS INSTALLATION IN A LOFT ON THE WESTERN FRONT.

From a drawing in colour by Lieut. F. Leist, R.O.I., official artist to the Australian Forces.

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our elation at victory. Many a wireless operator still at sea who received the Victory Message has survived the ordeal of being torpedoed by the pirates whose chiefs were forced at last to make a tardy surrender. A large number of their comrades, cut off in their prime through the same infernal agency, will never again manipulate a key or "listen in" to the messages of the ether waves. Being dead, they yet live; and cannot have been far away from their comrades at the great moment. Their heroism and their devotion to duty are handed on to their successors as a "Marconi Tradition," and we may be quite sure that no rejoicing can be deeper than theirs, that wireless has passed in triumph through the trials of the Great War to achieve the mighty destiny which awaits it in the Great Peace.

A "Surprise" Radio Appeal.

On October 31st last an Italian naval operator was "listening in" at Venice when a Marconigram dropped, as it were, "out of the blue." This message was addressed "To the Commander of the Fleet of the Entente." Its purport ran as follows:—

"The Committee of Public Safety of Trieste, in view of the grave state of the "city, wish to treat with the Entente Fleet. Come and meet us off Point Coarle. "Answer if you have received. We are waiting."

Dramatic indeed was the situation which had given rise to this wireless message. Two days previously the principal personages of all parties in this, Austria's principal seaport upon the Adriatic, had decided that the lack of order resulting from the disintegration of Austria demanded action upon their part. On the afternoon of October 29th they waited upon Baron von Fries Skene, the Lieutenant-Governor of the city, and demanded that he should hand over to their Committee of Public Safety the administration he was plainly powerless to conduct. After telegraphic communication with Vienna, the Governor complied, and asked for a safe conduct for himself and the naval commander of the port. His request was granted in both cases; and one of the delegates, Signor Pasigli, as he left the palace, stood up in his motor-car and proclaimed to the crowds waiting outside, "Trieste is no longer "Austrian—you are free."

It was from this committee, then, that the message emanated which dropped on Venice "all unawares." At the despatching end, members of the committee stood round the solitary wireless operator in Trieste as he discharged his functions. What would be the reply? The response came almost immediately. "All right, "quite all right." The anxious administrators heaved a sigh of relief, and asked whether, seeing they had only one operator, the Italian naval commander would wireless them his instructions at the fixed time of 9 p.m. Accordingly, punctually to the hour, Venice radiated a short message, instructing them that their representatives would be received on the following morning.

Three delegates boarded an ex-Austrian torpedo-boat and proceeded to Venice. They satisfied Admiral Marzolo of the great need of their city, and, before daybreak on the following day, twenty-four Italian units, strung in a long line over the sea, proceeded on their historic voyage. The procession was led by a destroyer conveying General Pettiti di Roreto, and, as the Italians landed, the surging crowd of citizens at Trieste broke all cordons in their struggle to approach the ships. Immediately the general placed his foot upon the ground, he proclaimed in stern and solemn tones, "In the name of His Majesty the King of Italy I take possession of the City "of Trieste." Thus was brought to a happy consummation the long-continued struggle of Italy to free her citizens on the eastern side of the Adriatic, handed over to Austrian tyranny by the iniquitous treaty of Campo Formio.

Through Tribulation to Glory.

Amidst the succession of thrilling incidents which have marked the last few

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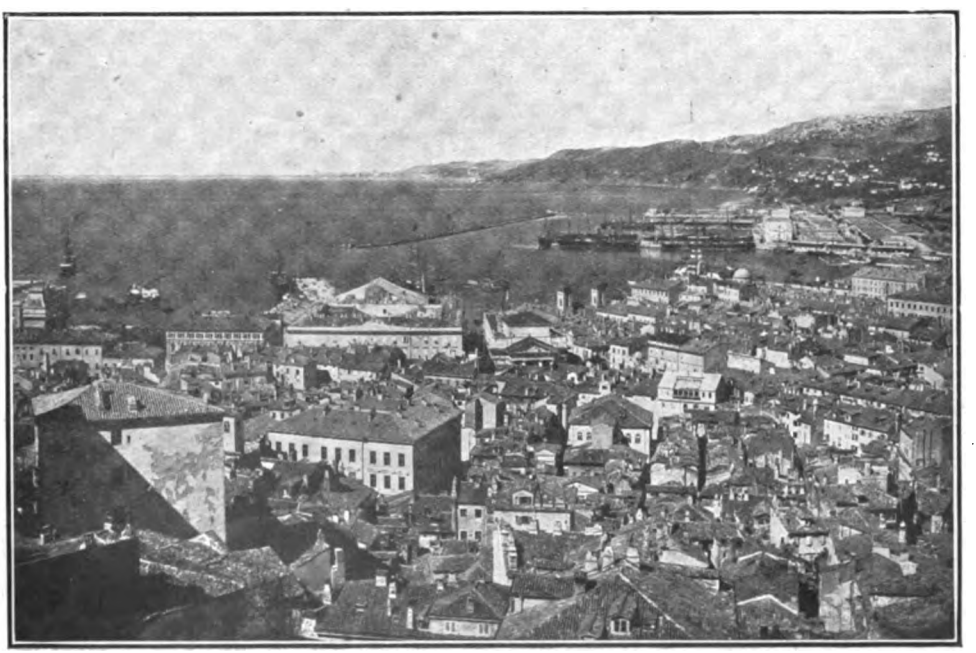
weeks, the part played by that gallant general and most capable soldier, Sir Charles Townshend, in the closing scenes of the Turkish *dénâcle* has been too generally overlooked. I am glad to notice that Colonel Repington has called attention to this omission in the *Morning Post*.

How the heart of the hero of Kut, kept though he was in honourable captivity, must have burned within him, when he realised that the work for which he had done and suffered so much was being accomplished by those he left behind him. Though in durance, his intercourse with the Osmanlis showed him plainly that Turkey was trembling upon the brink of surrender, and needed but a gentle push to urge her on the way. Man of action that he was, he disdained to sit in idleness, obedient to the doctrine of "wait and see." What steps could he take? Obviously his first task consisted of getting in touch with the Turkish Administration; his second to communicate with the British. He lost no time over it. On October 17th he interviewed Izzet Pasha, the Turkish Grand Vizier, and opened his eyes to the reality of the situation, learning from him on the other hand, the difficulties which stood in the path to peace.

Obtaining leave, he set out to accomplish the second item of his programme. Radiotelegraphy furnished him with the means. Once across the straits, General Townshend secured a special train to take him to Smyrna. Here he found himself in the midst of a population who lined the streets and cheered for peace as he drove through the town. So far secrecy had been maintained, but now—removed from Germany's sinister influence—his mission was openly avowed. In a tug he passed over the Turkish minefield at night, and before daybreak on October 20th reached Mitylene. Here wireless placed him in touch with England and he was able to report the situation to London. From Mitylene he proceeded to Mudros, accompanied by a Turkish naval officer, who was sent back with the least possible delay to fetch the duly accredited Turkish delegates.



A PANORAMIC VIEW SHOWING THE HARBOUR AT TRIESTE.

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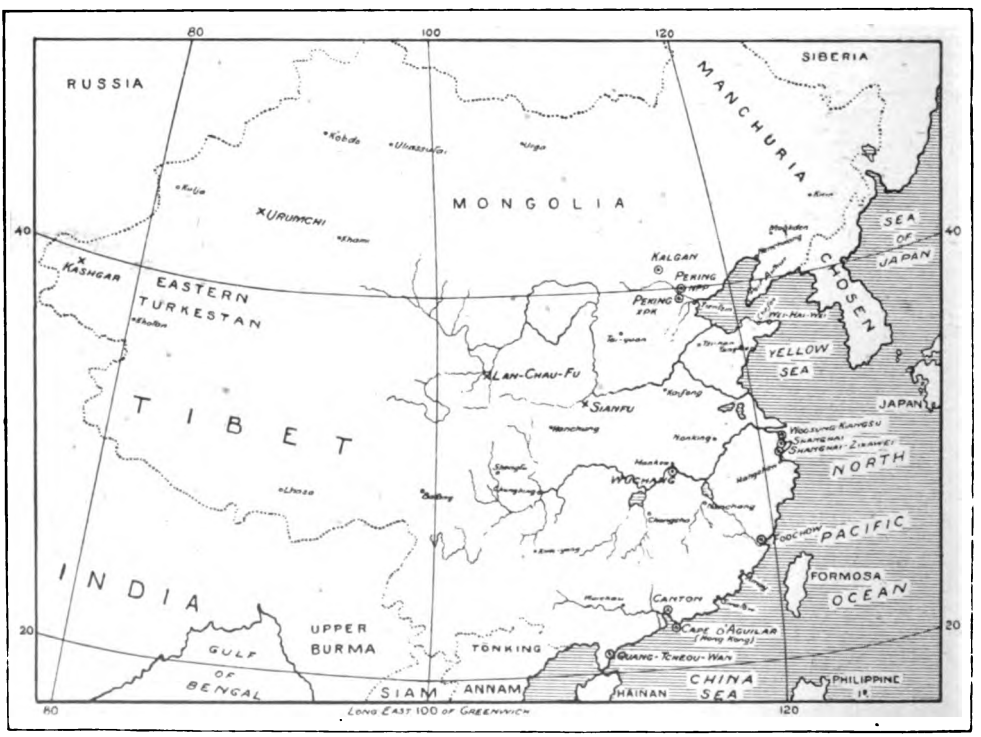
Chinese Wireless Enterprise

RAPID transit of intelligence and speedy means of communication rank high amongst the more important needs of every country.

Judged by modern standards, China is sadly deficient in both respects, for, although it is traversed in all directions by numerous routes, none of them are paved or metalled and all are badly kept; the vast internal trade being mainly water-borne. Think of it! We have here an area (in many parts of extreme fertility) possessing a grand total of just under four million square miles, with a population estimated at three hundred and twenty millions. Yet this vast expanse and teeming population has to content itself with less than six thousand miles of railway and thirty-six thousand miles of telegraph wires! Small wonder that everyone who knows the facts dwells upon the possibilities here opened for development and expansion.

The benefits which could be bestowed upon such a community by wireless telegraphy are enormous. Up to the present its development has been almost entirely confined to the coastal fringe. China is intensely conservative and slow to move, but the people are intelligent and industrious. The lessons of the Great War, now at an unlamented end, have been by no means thrown away upon her.



THE EXISTING WIRELESS STATIONS ARE MARKED ⊙, THOSE PROJECTED UNDER THE NEW SCHEME ARE MARKED X.

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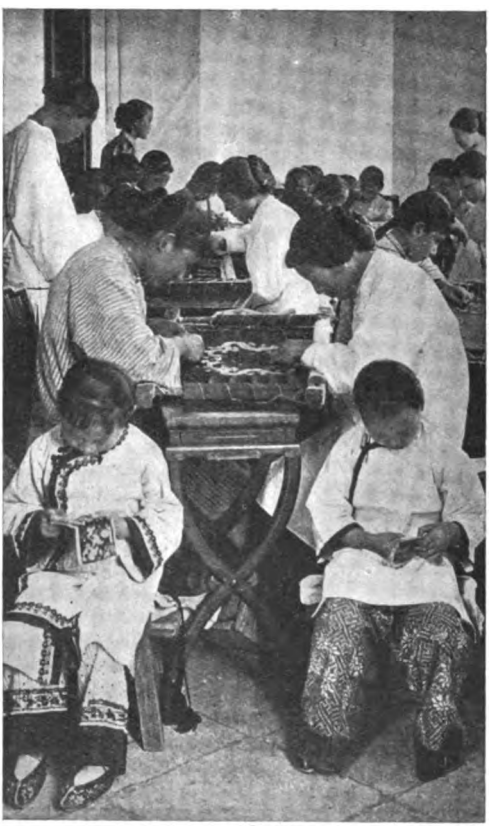
Prominent amongst these lessons stands out the importance of possessing a well-developed system of radio-telegraphy, and we have accordingly within the last few months seen a " stirring of the waters " and the conclusion of two important contracts relating thereto.

The Chinese realise their need of wireless, but are also sensible of a lack of " worldly gear." They have supplied the former need by contracting with the Marconi Company for two hundred wireless telephony sets, whilst they have arranged to meet the financial difficulty by borrowing £600,000 from the British Company, on the strength of Treasury Bonds bearing an interest of 8 per cent., repayable over a period of five years, the first instalment of liquidation to start after five years' time. These bonds have been placed upon the market by the Marconi Company and were immediately over-subscribed.

A second contract followed close on the heels of that above referred to, and—under its provisions—China will be furnished with a chain of stations spanning her vast territory, and giving the immense stimulus to trade which instantaneous communication inevitably brings in its train. On our sketch map will be found, marked with a cross, the position of the installations at present arranged for, at Kashgar, Urumchi, Langchowfu and Sianfu. The reasons for this selection of centres will be best gathered from the particulars which follow.



[*Underwood & Underwood.*

CHINESE GIRLS MAKING EMBROIDERY.

Kashgar, at one time the capital of an independent Mohammedan kingdom, lies in Eastern Turkestan. It stands in a rich oasis at the confluence of highways leading eastward to Pekin, southward to British India, and north to Russia. Urumchi, the Tihwa-Chou of the Chinese, constitutes the headquarters of the Chinese Government in Turkestan. It is surrounded by double walls and commands the only practicable defile for troops into the Eastern Provinces. Langchowfu, in Western China, was mentioned by the great Italian explorer, Marco Polo, in the thirteenth century and still remains the capital city of the Province of Kansu. It is situated amidst commanding heights and in a district containing coal mines. Sianfu (otherwise Singanfu), in the Hwang-ho Valley, is another of China's historic cities, standing at the centre of a vast wheat-field, and forming the point where a number of important trade routes converge.

The new stations will exceed in power and range of transmission any others in the Republic, and as a purely commercial overland telegraph circuit the scheme will constitute a world record. It is a source of no small satisfaction to reflect that this new departure in China is due to the enterprise of a British company, and that supervision of the construction will be conducted by a British engineer.

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Wireless in Many Lands

Now that Belgium is being rapidly cleared of the enemy who has oppressed her so long, it would appear a fitting opportunity to turn our thoughts towards what Germany was doing when she invaded King Albert's territories. The British Press has repeatedly pointed out that she thereby violated international agreement to which she herself was party. This, however, conveys to the average newspaper reader simply that Germany broke faith; it does not emphasise the fact that it meant the levelling of a blow against the world's polity. Belgium was not only national, but international. That characteristic it owes to its history.

In the break-up of the Roman Empire the Franks over-ran the country and settled there. During feudal times the petty local rulers grouped themselves under the over-lordship of the Dukes of Burgundy. When Burgundy's most powerful ruler, Charles the Bold, met a violent death in 1477 this part of his dominions passed into the hands of the Austrian House of Hapsburg, and through them fell under Spanish dominion, remaining Catholic after the Netherlands had succeeded in forming a Protestant republic. The peace of Utrecht (which closed Marlborough's wars) transferred the Low Countries from the Spanish to the Austrian Hapsburgs, and under their dominion they rested until the French liberated them therefrom. When the European Powers re-arranged the map of Europe after the fall of Napoleon Bonaparte, Belgium was united with Holland. This experiment in statesmanship failed, and the London Congress of December 20th, 1830, recognised Belgian independence, placing it under international protection.

OUTSIDE THE SCHOOL IN ROTTERDAM.

It will thus be seen that Belgium has been subjected for a thousand years or so to a whole series of foreign rulers, and that the cohesive power of national feeling has enjoyed a chance of development of less than a century. When we remember that her population of mixed Germanic and Celtic origin are still classified by language into two fairly equal divisions, it is obvious that Belgian feeling lent itself in pre-war days naturally to international activities. The devotion to patriotism which her population has displayed all through this war has been, therefore, all the more a source of admiring wonder to us all.

Internationalism in pre-war days manifested itself in many directions. The colonies of the Belgian Congo were originally the private property of King Leopold, and next an internationally recognised "free State." Only since 1907–8 has it assumed the status of a colonial possession.

Radiotelegraphic organisation displays a similar trend. The Belgian company has embodied this fact in its title, that of the Société Anonyme Internationale de Télégraphie Sans Fil, and carries it out in actual working. It exploits wireless telegraphy on vessels of the mercantile marine of all European countries with the exception of our own, Italy, France, Germany and Austria.

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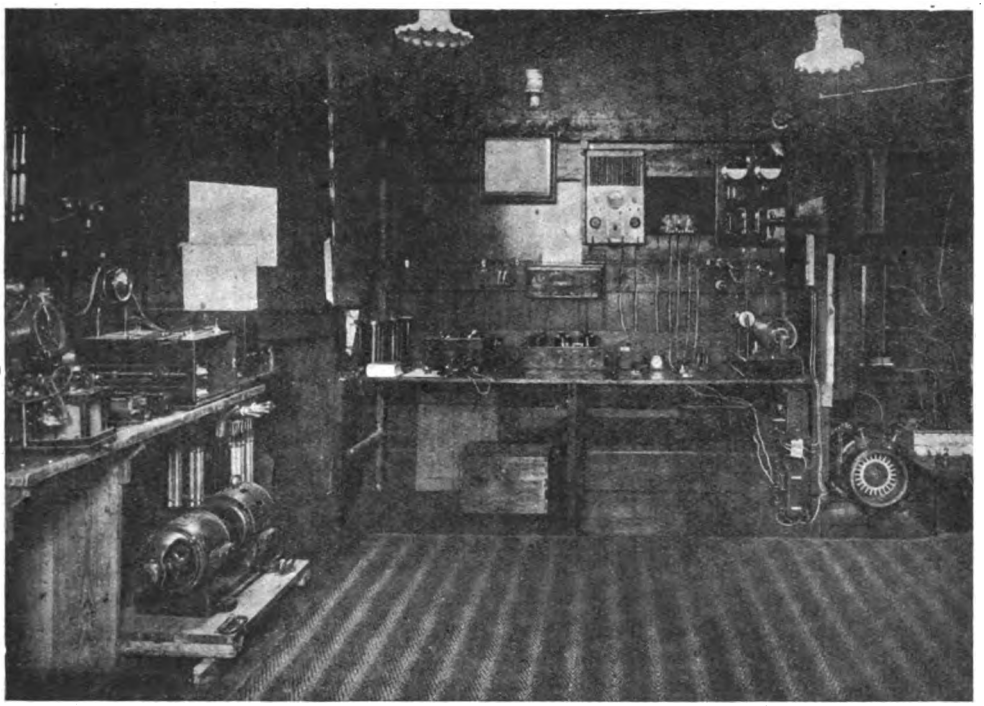
When (under the title of Compagnie de Télégraphie Sans Fil) they first started business the young men engaged by them for service in the capacity of radio-telegraphists on board ship used to be sent to the school of the Marconi International Marine Communication Company at Liverpool, in order to undergo the customary course of training which sufficed to meet the requirements of those early days (1903).



THE INSTRUMENT ROOM IN THE ROTTERDAM SCHOOL.

After receiving initial training in Liverpool, the students were placed on board ship as junior operators, there to complete their tuition. This method prevailed until 1909, when the fitting of Dutch merchant vessels began to expand very rapidly, with the result that the Belgian company fitted installations in a very large number of vessels registered in the Netherlands and in the Dutch East Indies. It was this development which was responsible for the establishment of a school, in February, 1910, at Rotterdam, where the first home of the school was located in the Tivoli Building. Here learners were trained in telephonic reception, in the theory of electricity and magnetism, and in the rules and regulations of the service. For opportunities of imparting practical tuition in the tracing of faults, as well as in the maintenance and manipulation of wireless gear, the company was indebted to the courteous permission of the Holland-America Line managers, who lent the wireless cabin of the s.s. *Rotterdam*, when in port, for that purpose. It was obvious that this arrangement could only serve as a makeshift, and the large number of pupils, belonging not only to Dutch but Danish, Norwegian, Swedish and Belgian nationality, who were attracted by the opportunities afforded caused larger premises to be taken. These were located in 1911 at 16 Boompjes, and early in 1914 the larger and more suitable building at 23a Boompjes was acquired for that purpose. The accompanying photographs of exterior and interior views will show the character of the present school. Later on the Belgian company established an inspectorate at Amsterdam, and took the opportunity at the same time of relieving the pressure

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upon their establishment in Rotterdam by opening a fresh school in the former city. The photograph which we reproduce on this page gives a very fair presentment of its handsome building, and the continued prosperity of these two radiotelegraphic training establishments in Holland speaks volumes for the rapid expansion of wireless and for the enterprise of the S.A.I.T. An arrangement has, moreover, been entered into with the Director of the School of Navigation at Amsterdam, providing that opportunities shall be given for enabling future officers of the Dutch mercantile marine to obtain the wireless instruction necessary for fitting them to qualify for the Netherlands Government's radiotelegraphic licence.

But the activities of the Belgian company, as we have seen, are far from being confined to the Low Countries, and circumstances have necessitated the provision of training centres for radiotelegraphists at Athens, Christiania, Lisbon, Barcelona, Bilbao and Cadiz, some of which we illustrate here.

THE BARCELONA SCHOOL FOR WIRELESS STUDENTS.

THE AMSTERDAM BUILDINGS.

In earlier days the S.A.I.T. made a rule to engage as telegraphic students only such applicants as were already able to receive Morse signals by sound at a minimum rate of fifteen words per minute. The rapid increase in the number of continental ships fitted with wireless which has come about during the past few years has caused this source of supply of students with some preliminary knowledge to be completely exhausted. Steps had therefore to be taken for starting with the absolute

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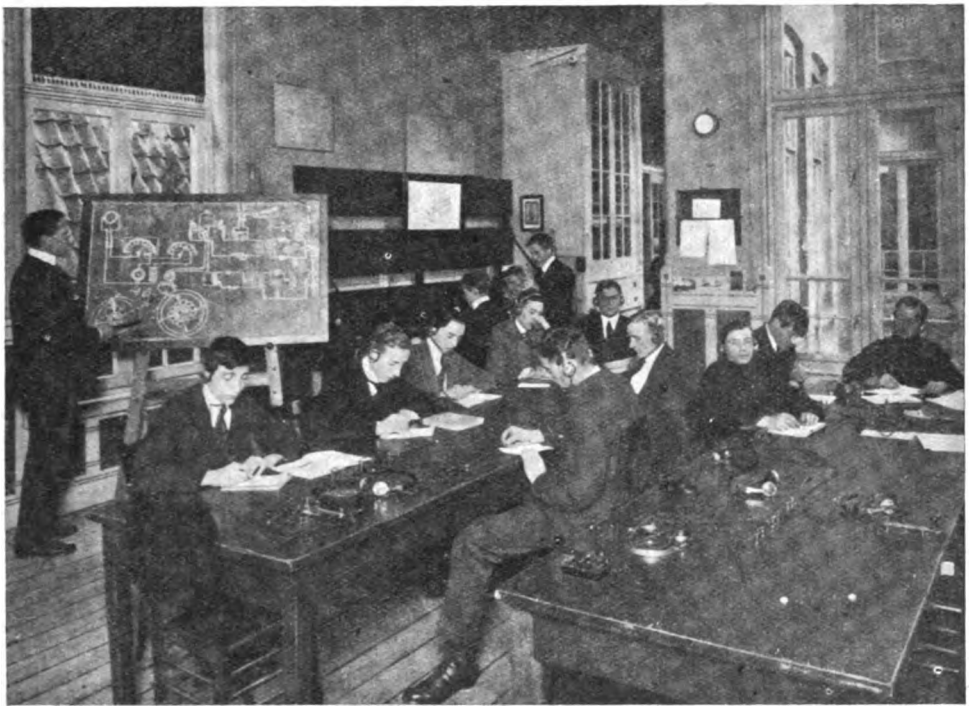

PUPILS AT WORK IN THE SCHOOL AT AMSTERDAM.

" Raw Material," and the curriculum was enlarged so as to give complete training to suitable applicants with no specialised knowledge whatsoever in telegraphy. Both day and evening classes to cater for this need have been opened at the various centres enumerated above, where for a small monthly fee pupils can be taken and trained *ab initio*. These extended classes have been placed at the disposal of ships' officers desirous of acquiring an insight into the practice of radiotelegraphy. In the course of last year a Royal Decree, promulgated by the King of Spain, rendered it compulsory for all Spanish ships of 500 tons and over to be equipped with wireless installations. This naturally gave a great impetus to the study of the science in Spain, and the existing school of the Belgian company, located at 5 Gran Via Layetana, in Barcelona, was organised to meet the demand thus created. A large number of students are receiving instruction at this school whilst other establishments have been opened, one at No. 5 Calle Zorilla, Cadiz, and another at 13 Calle Buenos Aires, Bilbao.

However, the good work done in this connection by the Belgian company, with the object of enabling the decree of the Spanish Government to be carried out, is further supplemented by the public spirited action of Messrs. Sota y Aznar, the well-known shipowners of Bilbao, who have arranged for tuition to be given in wireless to Spanish cadets on board their steamer the *Artagan-Mendi*, a fine specimen of marine architecture, which, built originally as a cadet ship at the Euskalduna Works, at Bilbao, has been pressed into the service of carrying cargo and constitutes perhaps the largest Spanish cargo vessel afloat. Our illustration depicts this new steamer lying at Bilbao; she started her maiden voyage on October 16th last year, and carries a wireless instructor in addition to the telegraphist. This instructor is supplied by the Belgian company, and his class is composed of sixteen pupils entered as cadets on board.

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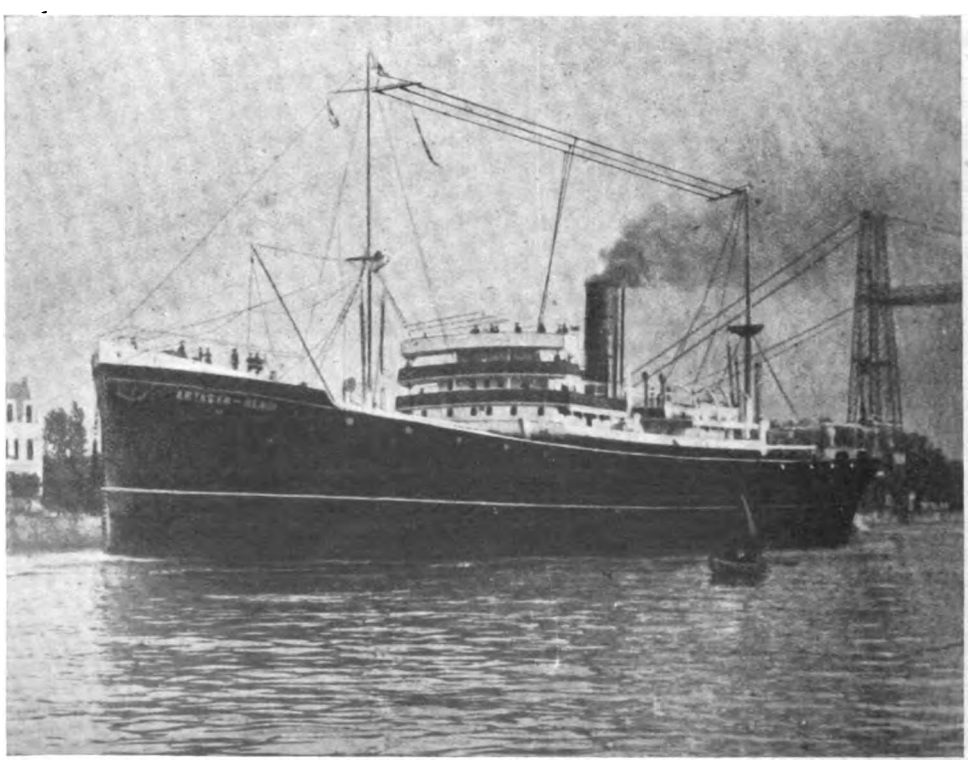
The Greek Government, in the course of 1917, enacted the compulsory establishment of wireless on all Government vessels of 300 tons dead weight and over, as well as for all vessels of 1,000 tons up. This enactment naturally brought in its train a fresh demand for wireless operators, and the Hellenic Government took in hand the task of establishing schools for the purpose of instructing young men to fill the vacancies. The Belgian company had been affording every assistance in their power, and their assistant inspector at Athens has been lent to the Greek Ministry of Marine for the purpose of instructing their pupils.

The few particulars which we have been able to enumerate above will serve to give an indication of the widespread nature of Belgian radiotelegraphic enterprise as exemplified in some of the many lands which form its field of operation, as well as to illustrate the point which we made in starting, with regard to the international character of Belgian activities. But, in justice to the company, we must ask that our examples shall not be taken as exhaustive. We have not referred, for instance, to the arrangement made with the Netherlands shipowners, whereby ships' officers can be given sufficient training at the Amsterdam and Rotterdam schools to equip them with sufficient knowledge successfully to undergo the Dutch Government's Second-Class Licence Examination. Nor have we made any allusion to the training which has been given in the S.A.I.T. Netherlands schools to Belgian soldiers interned in Holland during the course of the war, with the object of enabling them to acquire knowledge suitable for securing civil employment after the cessation of hostilities.

As a matter of fact, additions and developments have been going on even in war-time, and the immediate future is likely to witness a considerable expansion of radiotelegraphic activities in Belgium, so soon as peace conditions enable men's energies to be turned in fresh directions.



THE SPANISH STEAMER S.S. "ARTAGAN-MENDI," USED AS A TRAINING SCHOOL FOR WIRELESS CADETS.

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The Design and Construction of Apparatus for the Wireless Transmission of Photographs

By MARCUS J. MARTIN

Article I.

ON pages 74 to 98 of the small handbook on *The Wireless Transmission of Photographs* a brief description is given of a system of radio-photography known as the "Telephograph," and this system, the outcome of several years' research work, is one that up to the present has given, from an experimental point of view, the most satisfactory results.

As far as the writer is aware very few articles, other than those which have appeared from time to time in THE WIRELESS WORLD, have been published on the telegraphic transmission of photographs either by wireless or other methods, and none whatever have appeared on the construction of photo-telegraphic apparatus.

The present series of articles, which deal exclusively with the design and construction of the apparatus used in the telephograph system of radio-photography, have been submitted with the purpose of supplying sufficient data to enable anyone who so desires to construct a similar experimental set of their own, but it must not be taken for granted that the methods and apparatus employed are the best to use for the purpose under discussion. It is a long step from the laboratory to commercial practicability, and as at the present time all radio-photographic systems are in a

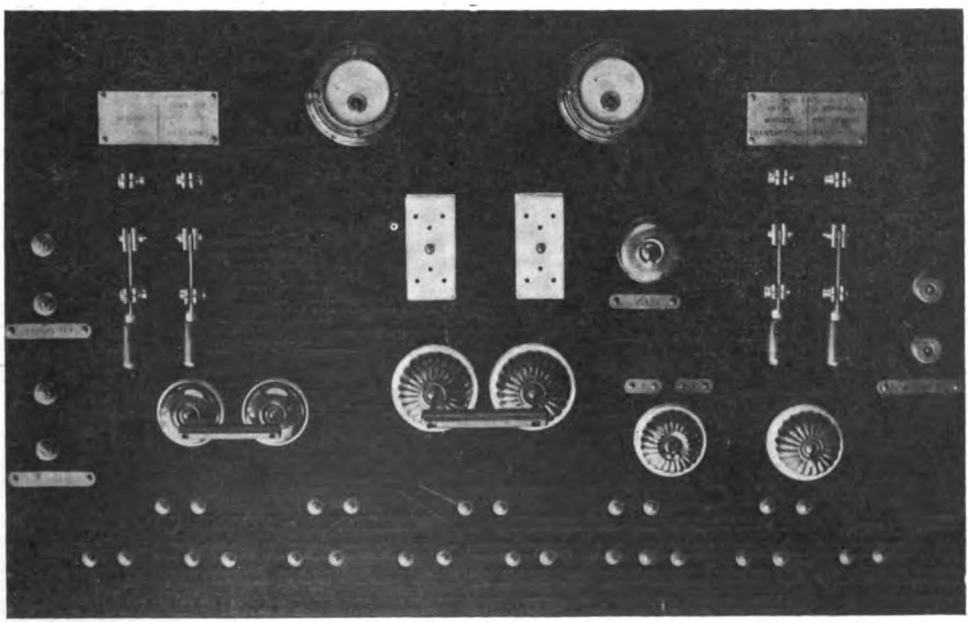

FIG. I.

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more or less experimental stage, there is a vast amount of original work to be undertaken before any wireless system can compete with the systems of photo-telegraphy at present in use for working over metallic conductors.

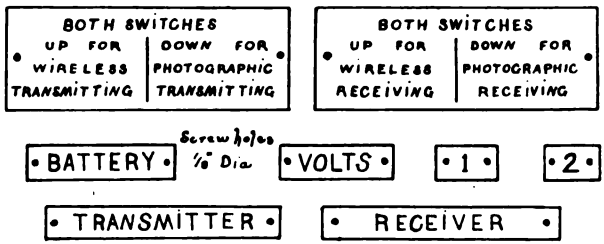

FIG. 2.—SWITCHBOARD NAME-PLATES.

While the information given in these articles is such as would enable a complete experimental station to be built, the main idea is to provide, for really serious workers, a practical groundwork from which improvements can be made that will eventually culminate in a really practical commercial system.

It should be noted, however, that under no conditions whatever can wireless apparatus of any description be constructed while the present restrictions are in force; therefore these articles will be confined entirely to the photo-telegraphic side of the subject, and only those pieces of apparatus described that in no way infringe the regulations.

From a study of the description and diagrams given in the volume already referred to it will be seen that numerous pieces of apparatus are employed worked

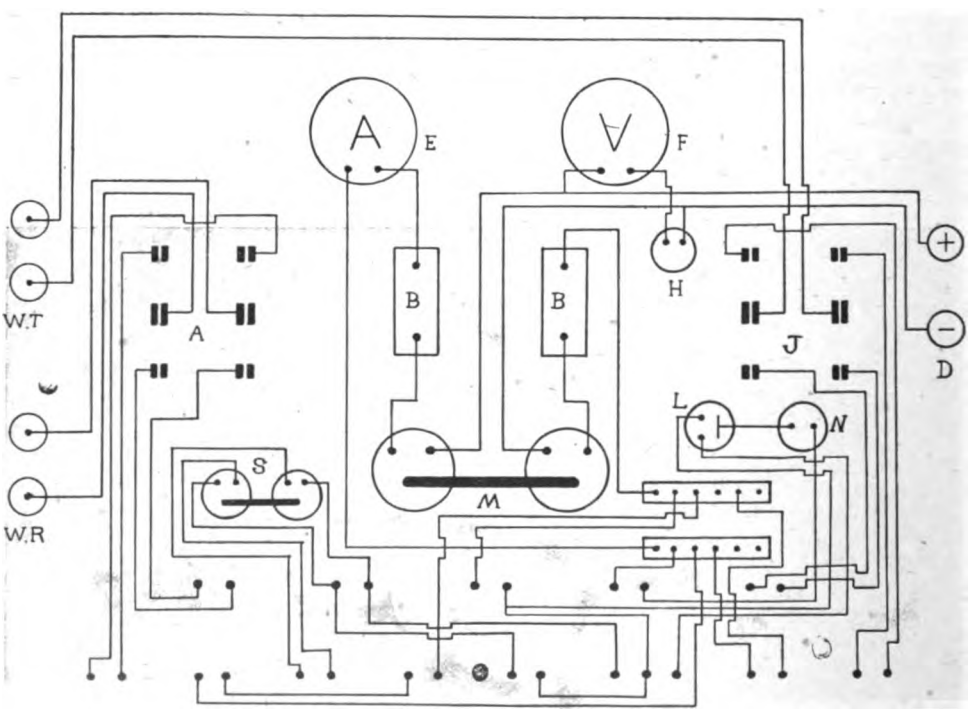

FIG. 3.—F, VOLTMETER; E, AMMETER; A, WIRELESS RECEIVING C.O. SWITCHES; J, WIRELESS TRANSMITTING C.O. SWITCHES; H, VOLTMETER SWITCH; D, BATTERY TERMINALS; M, MAIN SWITCH; B, FUSES; L, 5-AMP. LAMP SWITCH; N, TWO-WAY SWITCH; S, 5-AMP. D.P. SWITCH; W.T., WIRELESS TRANSMITTING TERMINALS; W.R., WIRELESS RECEIVING TERMINALS.

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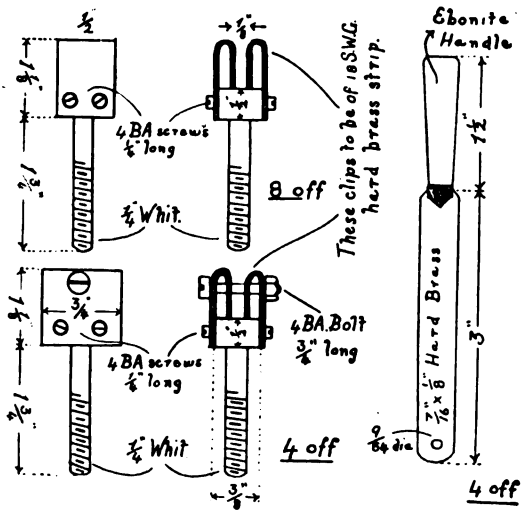

FIG. 4.—DETAILS OF CONSTRUCTION OF S. P. C. O. KNIFE SWITCHES.

from several independent sets of batteries, the various operations being controlled through a number of switches. For ease in connecting up and operating and for the quick tracing of faults the switchboard about to be described was designed, the idea being to dispense with the several sets of batteries and to work the instruments from a main source of supply, and to include the major portion of the wiring on the board and so render it only necessary to run leads from the different instruments to their respective terminals on the board.

The disposition of the meters, switches, etc., will readily be seen by reference to Figs. 1 and 2, and the wiring and other arrangements from Figs. 3, 4, 5, 6 and 7.

The board, of polished mahogany, measures 48 in. long by 30 in. wide by 1 in. thick, a recess 1½ in. deep being provided at the back for the protection of the connections. The fittings on the board consist of the following: 1 volt and ammeter of the spring-controlled type, reading 0-20; 1 voltmeter switch; 1 10-ampere double-pole main switch; 1 5-ampere single-pole tumbler switch; 4 single-pole change-over knife switches; 1 5-ampere single-pole two-way tumbler switch; 1 5-ampere double-pole tumbler switch; 2 10-ampere cut-outs; 2 terminal blocks, instruction plates and terminals. A drawing of the S.P. change-over knife switches *J* and *A* is given in Fig. 4; but these can, if desired, be replaced by D.P. change-over tumbler switches. The position of the terminal blocks, and also the connections at the back of the board, is given in the wiring diagram, Fig. 3.

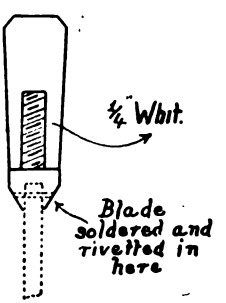

FIG. 4A.—METHOD OF SECURING BLADE AND HANDLE.

The wiring from the terminals at the bottom of the board, numbered 1 to 13, to the various instruments is given in the diagram Fig. 7. Leads run from terminals marked 1 on the board to the local terminals on the relay *S*; from terminals 2 to wireless sending key; from terminals 3 one lead runs to contact spring on the shaft of machine, and the other lead to one terminal of coil winding of relay *S*; from terminals 4 to coil windings of relay *K*; from terminals 5 to circuit breaker on machine; from terminals 6 to clutch; from terminals 7 to contact breaker *L*; from terminals 8 to local contacts of telephone relay *U*; from terminals 9 to photographic receiver; from terminals 10 to telephone relay windings; from terminals 11 to telephones; from terminals 12 to coil windings of contact breaker *L*; from terminals 13 to local contacts of relay *K*.

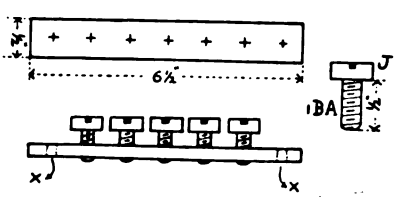

FIG. 5.

The various circuits can easily be traced by reference to Figs. 3 and 7 accompanying this article, and Figs. 35 and 51 in the volume already referred to. The terminal blocks, which are situated in a convenient

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position at the back of the board, are given in detail in Fig. 5. They consist of two pieces of brass bar, $6\frac{3}{4}$ in. by $\frac{1}{2}$ in. by $\frac{1}{4}$ in., the $\frac{3}{16}$ in. diameter holes *X* to take the holding down screws being drilled $\frac{3}{8}$ in. from the end. The remaining holes are spaced 1 in. apart and drilled and tapped 2BA to take the screws *J*, ten of which will be required, together with ten 2BA plain brass washers. The two rows of terminals at the bottom of the board are made from 3BA cheese-headed brass screws, $1\frac{3}{4}$ in. long, 27 of which will be necessary, together with 54 brass hexagon nuts (standard size) and 27 plain brass washers. Their arrangement is given in Fig. 6. The instrument leads are composed of fairly heavy silk-covered flexible cord, the ends being provided with thimbles for attaching to terminals. Their length will, of course, depend upon the distance of the board from the various instruments. The terminals should be numbered at the back of the board to facilitate wiring up. The instruction plates are cut from 18 gauge sheet brass and engraved with wording as shown in Fig. 2, the engraving being afterwards filled with black wax.

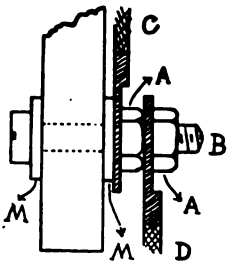

FIG. 6.—M, WASHERS; A, HEXAGON NUTS; C, PERMANENT CONNECTION; D, INSTRUMENT LEAD; B, SCREW.

The method of working with this switchboard is somewhat similar to that given on page 95 of the volume mentioned, and is as follows: At the transmitting station, everything being ready for work, the change-over switches *J* are placed in the position for photographic transmitting (switches down). The switch *L* is closed and the two-way switch *N* is placed on No. 1 contact, and the closing of these switches brings the clutch *F* into action and the machine begins to revolve. As soon as the whole of the line print has been transmitted the end of the machine shaft *D*, Fig. 36, engages with the spring *m*, breaking the clutch circuit and allowing the motor to run free. As soon as the machine stops, the switches *L* and *N* are opened and the machine drum run back to the starting position by hand.

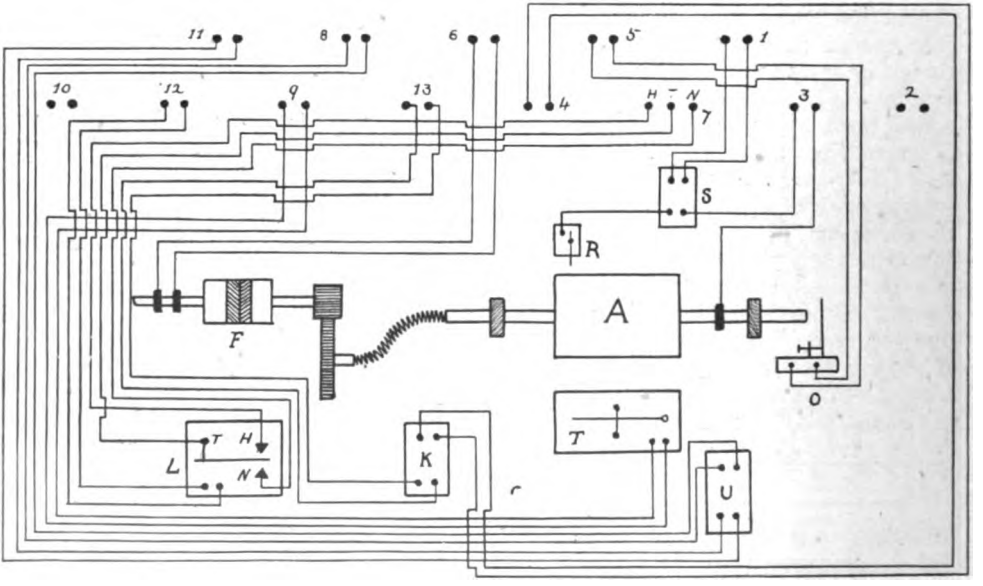

FIG. 7.—S, RELAY; R, STYLUS; T, RECEIVING INSTRUMENT; A, MACHINE; F, CLUTCH; O, CIRCUIT BREAKER; U, TELEPHONE RELAY; K, POLARISED RELAY; L, CONTACT BREAKER.

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At the receiving station the change-over switches *A* are placed in the position for photographic receiving (switches down), the switch *S* being open. The switch *L* is closed and the two-way switch *N* is placed on No. 2 contact. The closing of these switches does not bring the clutch *F* into operation until current from the telephone relay *U*, connected to the wireless receiving apparatus, operates the polarised relay *K*, which in turn completes the circuit of the circuit breaker *L*. When the armature of *L* is attracted, the circuit of the relay *K* is broken, the circuit of the clutch *F* is completed and the machine starts revolving. By keeping the switch *S* open the whole of the minute current from the telephone relay *U* is used to actuate the relay *K*. As soon as the clutch comes into operation and the machine starts revolving, the switch *S* is closed, the current from the telephone relay then passing into the photographic receiver as the circuit of the relay *K* is automatically broken by the circuit breaker *L*. As soon as the whole of the picture has been received and the machine breaks the clutch circuit, the switches *L* and *N* are opened and the machine drum run back to its starting position by hand.

(*To be continued.*)

Viva l'Italia!

WE offer our heartiest congratulations to the Fatherland of Marconi on the completeness with which the valour of the sons of Italy has attained her national aspirations. The special difficulties under which she has laboured all through this mighty struggle have been stupendous. Right richly has she deserved her success. May the bonds which have all through history united the countries which share the glory of being Senatore Marconi's birthplace and the locale of his strenuous radiotelegraphic activities knit the two nations even closer in the future than they have done in the past.

[*Official Photo—Associated Illustrations.*

WITH THE ALLIED FORCES ON THE ITALIAN FRONT. SENATORE MARCONI IN COMPANY WITH THREE BRITISH WIRELESS EXPERTS.

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In Memoriam

We chronicle with deep regret the passing, within a short period of each other, of Messrs. William Rushbrooke Dale-James, Frank Gray, and Clarence Campbell Armstrong, highly esteemed members of the staff of the Marconi International Marine Communication Co., Ltd., doing duty on shore. Well known to most seniors, and to many juniors in the Company's employ, they possessed the respect and goodwill of all with whom they were associated during their several years of service on sea and land, and who now offer condolence with the families of the departed.

W. R. DALE-JAMES.

The Marconi Company, and the staffs to which the deceased were attached, were represented at the obsequies, floral tributes from each being sent as a last mark of regard.

Mr. Dale-James was born at Sheffield, and at the time of his death on October 20th was in his thirty-sixth year. He was educated at St. Olave's Grammar School, Southwark, and, on leaving, entered the metallurgical laboratories of a Sheffield firm of steel manufacturers. After three years' experience of this work, Mr. Dale-James took a course in wireless telegraphy at the London Telegraph Training College, and joined the Seaforth School of the Marconi Company on April 10th, 1908. On qualifying he was appointed to the land station at Rosslare, subsequently being transferred to Crookhaven. After a considerable experience of handling wireless traffic from ship to shore Mr. Dale-James was transferred to the sea-going staff, and sailed in various ships of the Cunard, White Star, and C.P.R. Lines. In 1911 he was transferred to the Belgian Company, and sailed in several Spanish liners. On returning to England in 1913, he was appointed to the *Marmora* and made Travelling Inspector. Whilst attached to this vessel Mr. Dale-James served through her first commission as an auxiliary, subsequently transferring to the s.s. *Saxon*, from which he retransferred to the P. & O. Line.

At the end of 1916 Mr. Dale-James took up instruction work in the London School, and represented the Company's interest in the free training scheme at Newcastle-on-Tyne, and, later, at Portsmouth. More recently he acted as holiday relief to the Superintendent at Southampton, and at the time of his death was temporarily in charge of the East Ham Depot.

F. GRAY.

Mr. Gray, who died on September 23rd, was only twenty-five years of age, and was engaged in instruction work in the London Marconi School. He was educated at the Wesleyan School, Kentish Town, and was the first member of the Evening Classes, comprising about 100 students, to gain the First Class P.M.G. Certificate and graduate to the Day Classes. On appointment to the staff on May 11th, 1913, he joined the s.s. *Uranium*, subsequently serving on the s.s. *Denbighshire*, *Kestalia*, and, among others, the s.s. *Tuscania*, *City of Paris*, *Obuasi*, and *Themistocles*.

C. C. ARMSTRONG.

Mr. Armstrong was a native of Melbourne, Australia, and was educated in that city at Fitzroy Grammar School. He received his training at the Warrington Wireless School, and joined the Marconi Company with a first-class certificate. On appointment to the staff, on September 22nd, 1912, he took duty on the s.s. *Armenian*, and, amongst other vessels, served on the s.s. *Oropesa*, *Runic*, and the Dublin-Holyhead mail boats. In March, 1916, he was attached to the Southampton depot for inspection work, where he died on October 21st, in his thirty-third year.

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Among the Operators

It is still our sad duty to record the death of the brave operators who have lost their lives at sea, by enemy action, in the wireless service of their country. Unfortunately, the list is not yet exhausted, but now that peace is upon us, we sincerely trust that the names yet remaining to be published next month will mark the end of it. The lives of the operators mentioned this month have been sacrificed as the result of hostile activities. Both on our own part, and on that of our numerous readers, we extend to the parents and relatives of these young men, who so nobly uphold the "wireless tradition," the deepest sympathy in their sad bereavement.

MR. WILFRED FRANK FREEMAN, formerly employed as chemist's assistant at Birmingham University, and at Messrs. Philip Harris and Company, Ltd., was born at King's Norton on December 22nd, 1899, and educated at Dennis Road Council School, and the Central Secondary School, Birmingham. He was trained at the City School of Wireless Telegraphy, Ltd., Manchester, and after gaining the P.M.G. Certificate appointed to the operating staff in April, 1917.

Born at Claines, near Droitwich, on March 24th, 1899, MR. THOMAS OWEN PRICE was educated at the Elementary School and the Grammar School, Bromyard, Worcester, and trained at the North British Wireless Schools, Ltd., Edinburgh. He received the P.M.G. Certificate, and was given an appointment by the Marconi Company in May, 1916.

MR. WILLIAM CHEETHAM was born at Oldham on August 19th, 1900, and went to the Waterloo Council School for his education. Commencing his career as a solicitor's clerk with Messrs. Ascroft, Maw, and Shimeld, he subsequently attended the City School of Wireless Telegraphy, Ltd., Manchester, and obtained the P.M.G. Certificate. Mr. Cheetham's service with the Marconi Company dated from March of this year.

Of Scottish birth, MR. DAVID MCGREGOR BRYCE, aged eighteen and a few months, was born at Irvine, Ayrshire. He received his education at Carluke Higher Grade School. Starting life as a mechanic at Messrs. Apthorpe's Motor Supplies, Glasgow, he turned his ambition to wireless telegraphy, and was trained at the North British Wireless Schools, Ltd., Glasgow, where he gained the P.M.G. Certificate. Mr. Bryce was appointed to the Marconi Company's staff in August last.

MR. CECIL BRICKELL was born at Petersfield on January 19th, 1901. He was educated at Alton National School, Eggars Grammar School, and Aldershot and County Secondary School. His training in radiotelegraphy was received at Marconi House School, and on qualifying for the P.M.G. Certificate Mr. Brickell was placed on the staff of the Marconi Company on September 30th, 1917.

Bedminster, near Bristol, was the birthplace of MR. EDWARD JAMES PHILLIPS, on January 26th, 1900. After receiving his education at the Boys' Holyrood Council School, and the Boys' Grammar School, Ilminster, he was employed in the office of the Clerk to the Guardians and Rural Council of Chard, subsequently being trained in wireless telegraphy at Marconi House School. He won the P.M.G. Certificate, and on May 6th last joined the operating staff of the Marconi Company.

MR. ARTHUR BYATT, born at Harrogate on June 3rd, 1900, was educated at the Municipal Secondary Day School there, and started his career as a chemist's apprentice. His wireless training was received from the Marconi instructors at the Central Technical School, Leeds, and on receipt of the P.M.G. Certificate he proceeded to sea in the Marconi Company's service in May of this year.

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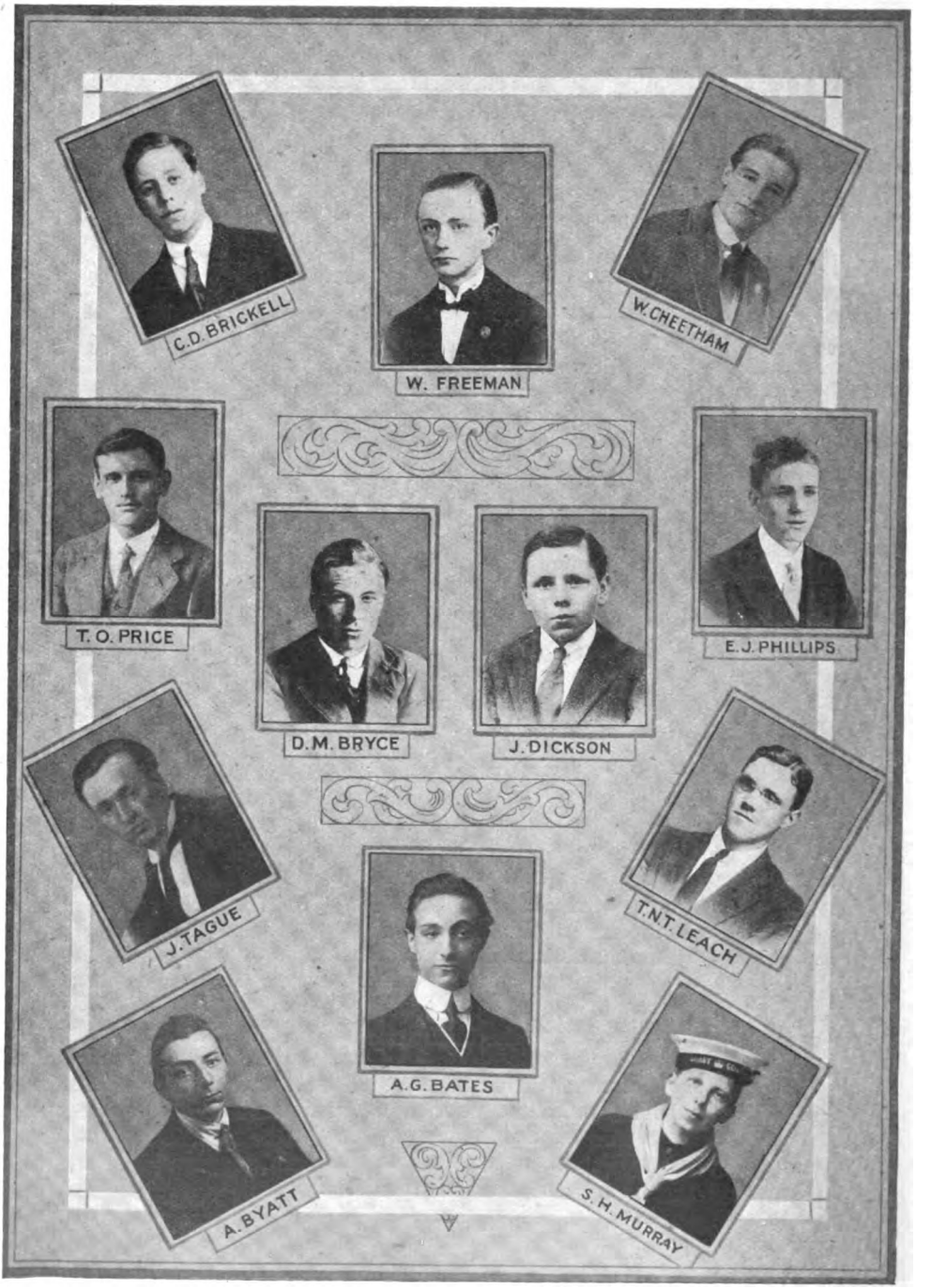
ROLL OF HONOUR.

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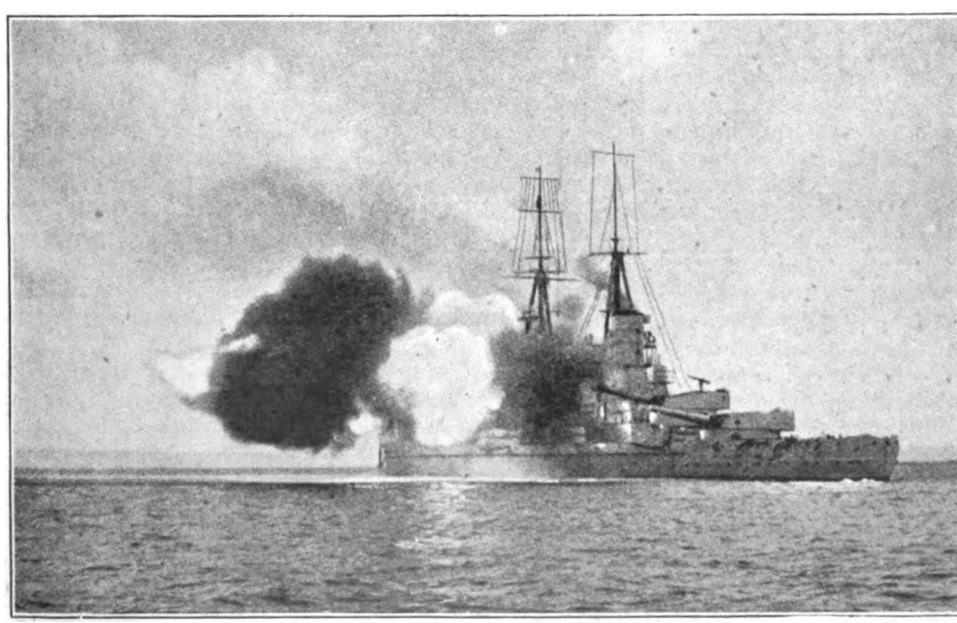
MR. JOHN DICKSON was born on June 15th, 1901, at Edinburgh, and received his education at Flora Stevenson's Board School. He was in the employ of Messrs. Lamb, Reid, Ltd., Fruit Salesmen, Edinburgh, and left that firm to take up wireless telegraphy. Trained at the North British Wireless Schools, Ltd., Edinburgh, Mr. Dickson qualified for the P.M.G. Certificate, and entered the service of the Marconi Company in July, 1917.

Born on May 9th, 1899, at Airdrie, Lanarkshire, MR. JOHN TAGUE was educated at St. Margaret's School, Airdrie, and afterwards was employed as a miner. Trained in wireless telegraphy at the North British Wireless Schools, Ltd., Glasgow, he obtained the P.M.G. Certificate, and joined the Marconi Company's staff on January 2nd this year.

Formerly a clerk, MR. ALFRED GEORGE BATES was born at Regent's Park on July 19th, 1899, and educated at the L.C.C. Schools at Mina Road, Camberwell; Eglinton Road, Plumstead; and Alexis Street, Bermondsey. He was admitted to the course of training at Marconi House School, and received the P.M.G. Certificate. Mr. Bates entered the Marconi service in August, 1917.

MR. STUART HAY MURRAY was born on August 14th, 1901, at Kilmadock, and attended Deanston Public School, Doune; the High School, Stirling; and the Royal Technical College Navigation School, Glasgow. His training in radiotelegraphy, under Marconi instructors, was received at the latter college. On gaining the P.M.G. Certificate, Mr. Murray was placed on the Marconi Company's operating staff last April.

MR. THOMAS NORMAN TELFORD LEACH first saw the light at Redhill, Surrey, on October 20th, 1900, and pursued his studies at Abingdon Grammar School. He was a student at Marconi House School, and successfully passed the P.M.G. Examination. On receipt of the Certificate, Mr. Leach was appointed a seagoing operator in April last.



[*Italian Naval Official.*

AN ITALIAN DREADNOUGHT FIRING BROADSIDES.

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Instructional Article

NEW SERIES (No. 9).

EDITORIAL NOTE.—Below we give the ninth of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

CONDITIONS NECESSARY FOR CHEMICAL ACTION (continued).

Light.—In the last article it was explained that in many cases the mere contact of two substances is not sufficient to cause chemical action to take place between them and that therefore energy has to be supplied to the atomic systems from an external source ; instances were given in which this added energy is supplied in the form of heat. The energy of light is another potent agent in many chemical actions.

Examples.—(1) Hydrogen and chlorine when mixed will not combine in the dark. On the exposure of the mixture to sunlight chemical action occurs and hydrochloric acid is formed.

(2) A very familiar example of chemical action by the energy of light is that which takes place when a photographic plate is " exposed," or when sensitised paper is left in the light. Briefly, if silver chloride, silver iodide, or silver bromide is exposed to light, coloured compounds, the exact composition of which is not precisely known, are formed. On these phenomena the photographic art mainly rests. Salts of other elements may be employed, but there can be no photography without light, and however complicated the process may be it depends upon chemical action induced by light.

(3) The reader may have noticed that, as a rule, green foliage is absent from places where the sunlight does not penetrate. In woods where the ground is in perpetual shadow green plant life does not flourish. Green plants quickly become blanched if kept in darkness, and every gardener knows that to produce good *white* celery he must earth it up well. The compound which is responsible for the green colour of vegetable life is chlorophyll and its production depends, so biologists believe, upon conditions of light and heat, its function being to nourish plants by absorbing carbon dioxide from the air. The point to note is that radiant energy from the sunlight produces vital chemical action within the tissues of plants.

Sound.—There are certain cases of chemical action known to occur through the agency of sound. If contact is insufficient we have to swing the atoms of different substances nearer to each other, or, in the case of a single substance to cause the atoms to swing so far apart that they remain so. (*See* the case of mercuric oxide, WIRELESS WORLD, November.) Heat is generally capable of performing the part of disturber but in the case of acetylene gas sound fulfils this part. A molecule of acetylene is composed of two atoms of carbon in combination with two atoms of hydrogen, and if exposed to the detonation of mercury fulminate it will break up. The carbon atoms are deposited on the sides of the vessel and the hydrogen is freed.

Carbon bisulphide also can be decomposed by this method.

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Electricity.—If a current of electricity is passed through acidulated water the latter is decomposed into hydrogen and oxygen—a typical example of chemical action taking place through the agency of electricity. Very many instances of **chemical decomposition** by **electrolysis** could be given. A case of **chemical combination** by electrical means has already been mentioned, that of the production of ozone, the allotrope of oxygen, by the passage of an electric spark through air. This is referred to again in order to make it clear that electricity can act as a system-builder as well as a system-breaker.

Pressure.—Chemical action will sometimes occur under the stimulus of pressure. Thus, if finely powdered lead is mixed with sulphur the two substances will combine if subjected to great mechanical pressure, forming lead sulphide.

If potassium chlorate mixed with sulphur is given a sharp blow with a hammer chemical action ensues accompanied by an explosion. If the reader is tempted to try this let him exercise great care whilst making the mixture, and then use only a pinch at a time. Potassium chlorate is liable to explode whilst being powdered by itself in a mortar and when mixed with red phosphorus it will decompose very violently if merely rubbed. On account of its strongly marked pyrotechnic qualities potassium chlorate is largely used in the manufacture of matches, flares and fireworks.

THERMAL EFFECTS OF CHEMICAL ACTION.

We have not yet completely exhausted the list of agents which will induce chemical action, but those mentioned are the most important. If the reader will refer back he will notice that with the exception of the essential condition of contact in cases where two or more substances are employed, each of the agents imparts energy to the system of molecules or atoms to which it is applied. So that whether the agent be heat or electricity or light the result is to alter the motions or positions of the material particles and to disturb their original grouping, causing decomposition, combination or some other form of chemical action. The amount of energy we have to supply depends, as has been explained, upon the degree of attraction existing between the atoms of the original molecules. As chlorine has a strong affinity for hydrogen, chloride of hydrogen is a very stable compound and in order to decompose it we have to bring in a large amount of energy; on the contrary, trichloride of nitrogen is so unstable that its atoms fly apart if it is submitted to a slight mechanical shock. It is desirable that we should be quite clear about the meaning of stability and instability because we are now going to think about what relation these qualities bear to the heat effects of chemical action.

Exothermic Chemical Action.—We have constantly tried to keep the student's mind fixed on the all-important question of energy and he may have been struck by the fact that a number of cases have been given in which chemical action occurs accompanied by the evolution of heat or of heat, light, and sound, such as an explosion—accompanied, that is to say, by the transformation of energy into a form in which it is generally of little or no use. Every chemical action has a heat effect. Sometimes heat is evolved and lost; sometimes heat is absorbed, and sometimes it is evolved but at once transformed into another form of energy.

A chemical action which results in **an output of heat** is called an **exothermic action.** We have seen that the stable compounds require more energy to bring about their decomposition than do the unstable ones because their atoms are harder to swing apart on account of their strong mutual attraction. It may, therefore, be concluded that if the decomposition of a molecule demands a large addition of energy to the system, *this must be the reverse of what happened when the molecule was formed—i.e.*, a large *output* of energy. In other words, if during a chemical action much heat is evolved—that is, if the action is exothermic—we

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may be sure that to *reverse* the action that heat or its equivalent of some other form of energy will have to be given back.

It also follows, generally, that exothermic actions tend towards the production of stable molecular systems. A molecule composed of two kinds of atoms, each of which kind has a marked affinity for the other, is generally the result of vigorous chemical action characterised by the transformation of much energy and may be regarded as stable because much energy would be necessary to undo the result of that action. It must be understood, however, that a compound molecule resulting from an exothermic action may not *necessarily* undergo decomposition by the mere application of heat; chemical actions are not in all cases so easily reversed.

Example.—Exothermic Action.—If hydrogen is mixed with chlorine and a lighted taper is applied to the mixture the two gases combine with violence, the action being highly exothermic. As might be expected, hydrochloric acid, the resultant compound, is extremely stable and in order to decompose it great heat —upwards of 1,500 deg. C.—has to be employed. This particular example happens to be that of an exothermic action which is reversible by the application of heat.

It must not be thought that the *whole* amount of heat evolved during an exothermic action is due to chemical action. Every chemical change gives rise to a physical change, and as a physical change results in an energy-transformation it is obvious that some of the energy given out when an exothermic chemical action occurs is due to the physical change which takes place at the same time.

Endothermic Chemical Action.—In some instances chemical action results in the **absorption of heat.** This class of action is called endothermic, and as it is the reverse of exothermic we may say that when a chemical action produces an absorption of heat, that heat must be given up when the action is reversed.

Generally speaking, if the formation of an atomic system requires the addition of much energy the component atoms have not a strong affinity for each other, and, therefore, for the decomposition of the molecule only a small impulse is needed. In other words, compounds formed as a result of endothermic action are in many cases unstable and during their decomposition—*i.e.*, the reverse of the said endothermic action—they evolve a large amount of heat.

Example.—Endothermic Action.—The production of carbon bisulphide, which is brought about by the direct union of sulphur and carbon, involves the absorption of heat. As might be expected carbon bisulphide is not particularly stable and when it decomposes heat is evolved.

HEAT AND TEMPERATURE.

Heat is the energy of molecular motion and as such it is, of course, without weight. Hence a body weighs the same whether it is hot or cold, provided that when it is heated no chemical action occurs which would alter the amount of matter in it. The difference between heat and temperature, not always clearly understood, may be explained as follows. Heat is energy which is manifested to a sense akin to that of touch by a certain effect; *the intensity of this effect* is temperature. The nature of the effect is too familiar to need description; we perceive it by means of our sense of heat or cold. Heat must be regarded as a physical *thing*, but temperature as that state of a body which decides whether it will receive heat from, or impart heat to, another body; for if two bodies are brought into contact with each other the one with the higher temperature will deliver heat to the other until each has the same temperature. A small piece of red-hot metal will give up heat to a much larger piece which, though not having reached a condition of red-heat, may have much more heat than the smaller one.

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The amount of heat received by a kettle of water whilst being brought to boiling-point is quite considerable yet the temperature the water attains (100 deg. C.) is not great. Conversely, if a small piece of iron wire is held in a flame it quickly reaches a high temperature (1,500 deg. C. – 1,600 deg. C.) but the amount of heat it acquires during the process is not large.

The determination of the amount of heat evolved or absorbed during a chemical action is a very important branch of physics and the practical value of such work is obvious when, for instance, one remembers that the price of fuel (coal, coke, oil, etc.) depends to a great extent upon its calorific or heat-producing value. The technical chemist when examining a sample of coal always performs what is known as the " heat test," because the *intrinsic* value of a fuel is measured in units of heat.

Units of Heat.—In the **C.G.S. system** the heat unit is called the **calorie**, and is that quantity of heat which will raise one gramme of water through one Centigrade degree of temperature. One thousand calories equal one **major-calorie.**

The **Centigrade unit of heat** is the amount of heat required to raise 1 lb. of water through 1 deg. C., and is written lb.-deg.-Cent.

The **Fahrenheit unit of heat,** written lb.-deg.-Fahr., is the amount of heat necessary to raise 1 lb. of water through 1 deg. Fahr. This is the B.Th.U., or British thermal unit.

* * * * *

Before leaving the subject of chemical action it will be well to sum up as follows. *All chemical actions are characterised by* (1) *the formation of new substances which may be either elementary or compound, or the formation of new substances, some elementary and some compound;* (2) *physical change;* (3) *a heat effect; absorption or evolution of heat.*

THERMO-CHEMISTRY OF THE SIMPLE VOLTAIC CELL.

In what follows we examine the action of a voltaic cell in the light of our knowledge of chemical action and its three characteristics. As a typical simple cell we will select that which consists of a plate of zinc and a strip of platinum foil, both immersed in a jar of dilute sulphuric acid. (Fig. 36.*) The student knows that such an apparatus is a source of electrical energy and that if the positive and negative terminals are joined by a conductor a current will flow through the cell (from the zinc to the platinum) and through the external circuit (from the platinum to the zinc). Remembering the law of the conservation of energy we recognise that this energy does not spring into existence the moment the circuit is closed; clearly it is not *new* energy originating within the cell just because the zinc, platinum, acid, and wire are brought together in the manner described. No, this energy actually *exists somewhere before we build up the cell, but not in the form of electricity.* Where is it and in what form does it exist? To find the answers to these questions we will study the chemistry of the cell.

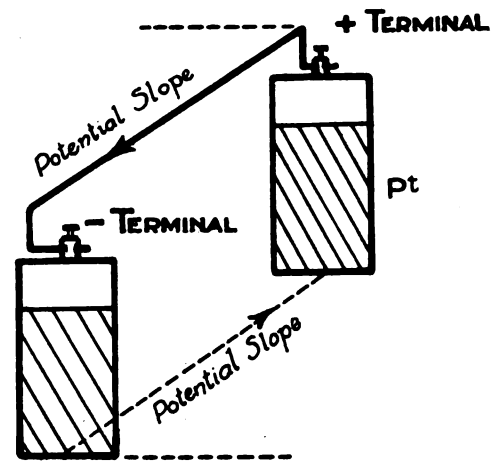

FIG. 36.

* As most people are familiar with the appearance of a simple voltaic cell we have in this diagram left the usual glass jar, acid, and hydrogen bubbles to the reader's imagination; he has simply to follow the text and consider the plates as immersed in acid to the extent indicated by the shaded portions.

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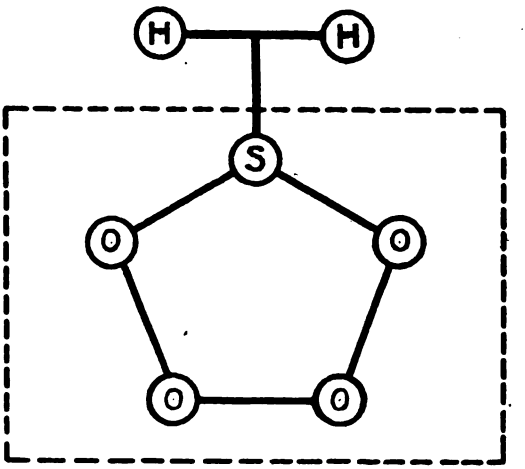

FIG. 37.

When the external circuit is completed as shown in the diagram :

(*a*) A current of electricity flows through the cell and external circuit.

(*b*) The external circuit becomes hotter.

(*c*) Bubbles of hydrogen are evolved at the platinum foil.

(*d*) The zinc plate commences to be dissolved.

(*e*) Zinc sulphate is formed and remains in solution in the electrolyte, which becomes weaker.

(*f*) The acid commences to decompose.

(*g*) The temperature of the cell, or what may be termed the internal circuit, rises.

Nothing chemical happens to the platinum, so that we have simply to consider a chemical action between zinc and sulphuric acid. Now, sulphuric acid is composed of hydrogen, sulphur, and oxygen, and a molecule of the acid contains seven atoms forming a system which may be represented by Fig. 37. That part of the system which is shown enclosed by a dotted line has, when considered as a group by itself, a strong affinity for zinc, with which it will combine readily ; zinc and the system (SO_4) may be thought of as straining to combine with each other. By this it is not meant that the (SO_4) system in a bottle of sulphuric acid is necessarily tending to make its way through the glass in order to reach the zinc tray on which the bottle may stand. The " straining " referred to is a word used to describe the power, held in leash, of zinc and (SO_4) to combine with each other. This tendency is inherent in the two materials and does not alter in degree with the quantity of material considered, nor does it depend upon the proximity of the one kind of material to the other ; it is as fundamental as inertia, and in degree as invariable as the velocity of light. Just as a stretched catapult has potential energy and needs only to be released for that energy to change into the kinetic form, so zinc and (SO_4) have potential energy and need only to be brought into contact in a certain way for that energy to change into a kinetic form.

Here we have the answers to the questions we propounded. The energy of our voltaic cell resides in the zinc and the acid in the form of potential energy.

(*To be continued.*)

Share Market Report

LONDON, *November 14th*, 1918.

DEALINGS have been very active in the shares of the Marconi group during the the past month. All classes of shares have recently shown a marked improvement which is generally maintained. Marconi Ordinary, £4 12s. 6d. ; Marconi Preference, £3 16s. 3d. ; Marconi International Marine, £3 11s. 3d. ; Canadian Marconi, 14s. 6d. ; American Marconi, £1 12s. ; Spanish and General, 14s.

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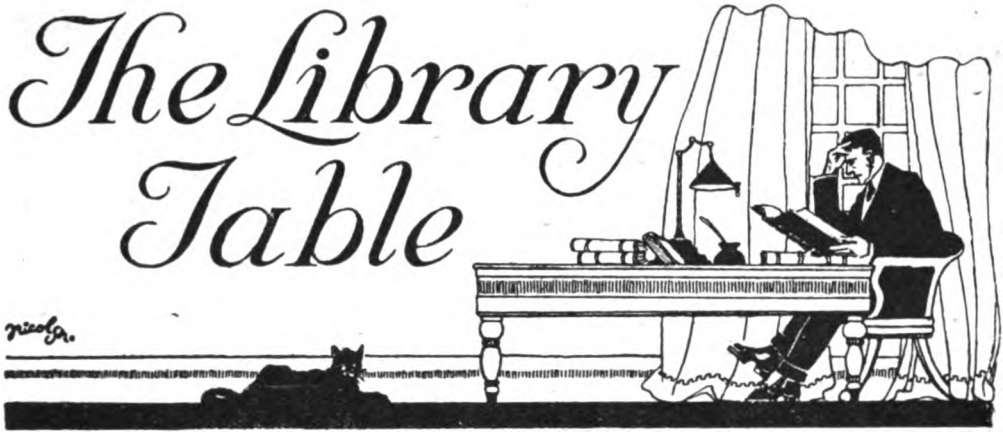

PRINCIPIOS ELEMENTALES DE TELEGRAFIA SIN HILOS. Por R. D. Bangay. Partes 1 y 2. London: The Wireless Press, Ltd., Marconi House, Strand. España: Compañía Nacional de Telegrafia Sin Hilos, Alcala 43, Madrid. Precio: España; 10 pesetas, Franqueo 1 peseta extra. America Latina, $2·25 neto; Franqueo 25 cents extra.

The progress of wireless telegraphy in Spanish-speaking countries has created an insistent demand for a textbook which shall put into the hands of students a volume introducing them to the theory of the subject. The test of years of experience has proved that no treatise more completely fulfils such requirements than Bangay's "Principles" in English, which has been the means of instructing thousands of English-speaking students to radiotelegraphy.

The volume which lies before us consists of the latest edition of the English treatise translated into Spanish, and possesses the clear and attractive format which we have learned to expect in the publications of the Wireless Press. We can assure our Spanish friends that it would be impossible for them to find any volume more fully suited to fulfil their requirements.

DARING DEEDS OF MERCHANT SEAMEN. By Harold F. B. Wheeler, F.R.Hist.S. London: George G. Happar & Co., 3, Portsmouth Street, Kingsway. 5s. net.

Mr. Wheeler believes in the "personal narrative" style of conveying history, and has published a number of historical volumes, taking a great figure-head as a centre round which to group his facts. This is a plan well suited to his style of narration, lending itself as it does to proportionate and well-balanced effect. In the present instance his subject necessarily involves the relinquishment of this method, with the result that the volume before us is one to keep by our side and enjoy piecemeal, rather than one to read through without a break to the finish. We hail the appearance of the book as peculiarly opportune at this present moment, when our foe is endeavouring to escape by fair words from the penalties which attach to his foul deeds.

WIRELESS WORLD readers are familiar with some of the deeds of gallantry narrated here. We may instance the torpedoing of the *Falaba* on March 28th, 1915. At that time (three and a half years ago) the civilised world was unprepared to witness, even in times of war, the callous and premeditated murder of innocent civilian passengers, largely women and children, on the high seas. For centuries such procedure had been left to the basest of outlaws and pirates, and the picture of torpedoes cutting a pathway for themselves through a mass of humanity struggling

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in the water, in order to reap a further harvest of death from non-combatant victims on board, sent a thrill of horror through every land.

A whole chapter is devoted to the torpedoing of hospital ships, a subject which Mr. Wheeler treats under the title of "The Crowning Infamy." This section of the subject is particularly skilfully handled. The author first explains the general rule that when a man has "done his bit" and been rendered *hors de combat*, civilisation considers him as—for the time being at all events—neutral and immune. He then proceeds to examine the Teutonic excuses for its infraction, proving the hypocrisy of each plea point by point, and illustrating his contentions by specific instances.

Wireless telegraphy naturally looms large all through the volume. In earlier days, before the arming of merchantmen was systematically carried out, radio-telegraphic gear constituted the victims' only method of defence, and formed for that reason the primary object of enemy attack. Count von Dohna-Schlodien, commanding the *Moewe*, expressly told one of his victims "had you used your wireless or touched your gun I should have given you a broadside."

Over and above a number of references scattered all through the volume we find a long chapter devoted specially to "Wizards of the Wireless," the keynote of which we cannot do better than summarise in the author's own words :

> The admiration of the Service for the operators is unbounded. They are known as red-blooded men. Not one of them has failed at the critical moment, a point borne out by officers of the ships chiefly concerned. Their personal messages to headquarters are usually couched in terms such as these : "Ship torpedoed, all effects lost, awaiting instructions." One operator sent a message of this kind three times in as many months, each occasion marking the torpedoing of the vessel he was on. He never flinched, and no word came from him suggesting a transfer to a station on shore. His assistant had been wrecked twice.

We have no space to do more than inform such readers as may have a taste for deeds of gallantry that they will find a rich store between the covers of this book. The subjects range from the heroism of the "Diehards," lined up on the torpedoed *Tyndareus*, under the command of Colonel John Ward, expecting at any moment to be precipitated into a watery grave, to the *sang-froid* with which the 25 Englishmen on board the *Borulas* saved the larger proportion of the 300 Greek half-caste and Egyptian passengers, simply through their national capacity for "keeping one's "head."

ELECTRICAL EXPERIMENTS. By A. Risdon Palmer, B.Sc., B.A. London.: Thomas Murby & Company. 1s. 6d. *net.*

This volume, by the author of *Magnetic Measurements and Experiments*, which we recently reviewed in these pages, is designed to cover a course in elementary electricity for the younger class of student. The aim is to provide instruction by a series of elementary laboratory experiments, the apparatus used being inexpensive and, in some cases, easily built up by the pupils themselves. In general, the line of instruction is good, but there are several matters which we think might be altered with considerable advantage to the student.

In view of the fact that practically all electrical students come into contact sooner or later with high frequency phenomena in radiotelegraphy, we think it unwise to suggest to students that "the pieces of insulated copper wire which are so arranged to connect the various pieces of apparatus to one another can, with advantage, be wound round a pencil although taking the form of a helix or spiral." In practice the advantages of flexibility and "give" so provided are largely negligible, and in addition the wire becomes a very effective choke for high-frequency currents. In our own experience we have known of experiments becoming complete failures by reason of the fact that the student has adopted this old-fashioned method on connecting the parts of the high-frequency circuit. In extreme cases where a certain amount of give is required two or three turns round the pencil should be ample,

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thus avoiding the totally unwarranted waste of expensive material caused by using two or three feet of copper wire when a few inches will do.

A praiseworthy feature of the book is the section of simple technical experiments connecting the instruction already given with practical apparatus with which the student comes into contact every day. Thus, we find the construction of a multiple push electric bell with its accompanying indicator carefully described; some experiments with a simple microphone and the commercial telephone, as well as a description of how to set up a simple Morse telegraph. We must, however, take exception to one statement made by the author in describing the single needle instrument, the construction of which has been shown. "The telegraph," says the writer, "used on some railway systems is very similar to that described above, "but for general purposes an instrument called a 'Morse Sounder' is employed, "because it is much quicker in its action, and can be used where messages have "to be sent over long distances, for which the needle arrangement would not be "sensitive enough." In cases where the sounder is substituted for the single needle instrument, neither speed nor distance have had any relation to the causes for the change. Any experienced telegraphist, accustomed to use both a single needle instrument and a sounder, knows quite well that the former is the faster instrument. Apart, however, from a few errors of this nature the book should be useful to those who require guidance for an elementary laboratory course for young students.

A SMALL BOOK ON ELECTRIC MOTORS, C.C. & A.C. By W. Perren Maycock, M.I.E.E. London: Sir Isaac Pitman & Sons, Ltd. 5*s. net.*

This little volume is well up to the usual standard of Mr. Maycock's works. In a breezy preface the author states that "this book will be of little use to electrical "engineering students, except those making their very first acquaintance with the "subject, for it is entirely free from technical and mathematical complications. "It will be of even less use to the electrical engineer, unless he desires a work for "recommending to his non-technical clients. Other kinds of engineers and engineering students, on the other hand, as well as all sorts of 'outside' people who are "concerned with or interested in electrical motors, should find this small book "of service." From this the reader will gather that the book is essentially a practical description of modern motors and their application, although as a matter of fact the technical side of the subject is dealt with more fully than one would expect from such an opening.

The first chapter deals with the advantages of electric power, many of which are not realised by the average non-technical man. Particularly interesting are the diagrams showing the comparative sizes of cables and shafts for transmitting a given power. Chapter 2 deals with direct current motors; chapter 3 with controls and control gear; chapters 4 and 5 with alternating current motors and their control, whilst chapter 6 is devoted to explanations of various technical matters and terms. A valuable feature of this and other books by the same author is the profusion of photographic illustrations of modern commercial apparatus, as well as the numerous diagrammatic illustrations which are particularly well drawn.

In these times, when those in charge of factories are no longer content to accept recommendation for electrical installations without at least making themselves acquainted with the rudiments of the subject, this little book should have a wide and ready sale. Incidentally, it is among the best propaganda for the electrical industry that we have seen, and it will be good policy on the part of many electrical manufacturers to make a present of this work to possible and actual clients.

A CORRECTION.—We regret that the price of *The Aeroplane Speaks*, by H. Barber, A.F.Ae.S., reviewed in our October issue, was inadvertently given as 6s. 8d. net. The price of this work is 8s. 6d. net.

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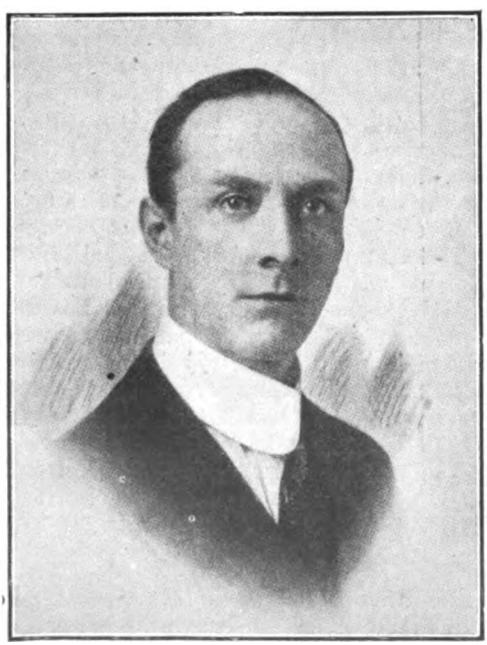
Personal Notes

SENATORE GUGLIELMO MARCONI, G.C.V.O., LL.D., D.Sc., has been elected by the Council as honorary fellow of the Society of Engineers.

OBITUARY.

We learn with profound regret of the sudden demise of MR. ERNEST THOMAS EDWARDS, late superintendent of the Eastern Division of the Marconi Wireless Telegraph Company of America. Born at Birmingham in 1883, he was educated at Bridge Street Technical School, and later entered the service of the Post Office as telegraphist. When nineteen he joined the Marconi International Marine Communication Company's service, performing duty at the Lizard, Niton and Liverpool Coast Stations, and aboard the s.s. *Minnehaha* and s.s. *Campania*. In 1904 he was engaged by the Marconi Wireless Telegraph Company of America, and, being an expert telegraphist, was on several occasions selected to demonstrate, both on land and at sea, the superiority and efficiency of Marconi apparatus over that of competitors. On one notable voyage from Buenos Ayres to Europe, testing was done side by side with the operator of the competing company, Mr. Edwards's skilful manipulation resulting in the adoption of the Marconi system. He was then placed in charge of Siasconset, an important station handling exceedingly heavy traffic, from and to ships inward and outward bound, under adverse and difficult conditions of working, which to-day are practically eliminated. From there he was promoted to the Sea Gate, L. I. Station, where he remained until June 1912, when he received the superintendency which he filled with ability until his death. He was well liked by his associates, and his genial personality is remembered by those in England who had the pleasure of his acquaintance. He leaves a widow and two young daughters.



MR. E. T. EDWARDS.

The funeral service was largely attended. A delegation of about twenty-five operators was present, and the Marconi Company was represented by Messrs. De Sousa, Sarnoff, Duffy, Chadwick and Pillsbury.

MR. THOMAS R. TALTAVALL, editor of the *Telegraph and Telephone Age*,

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New York, and the inventor of many useful electrical devices, died on September 2nd, aged 63 years. Mr. Taltavall was one of the most expert telegraphists of his day. He learned telegraphy in 1867, and eventually rose to the position of superintendent of the leased wire system of the Associated Press.

In 1890 he became editor of the *Electrical Age*, and in 1894 associated editor of the *Electrical World*, until he accepted the editorship of the *Telegraph and Telephone Age* in 1911.

MR. E. R. TIMBERLAKE, junior operator at the Fenchurch Street office of Marconi's Wireless Telegraph Company, Ltd., died on October 30th at his home at Catford. The internment took place at Hither Green cemetery, the coffin being covered with floral tokens of respect, including a beautiful cross from his colleagues. The City superintendent represented the Company at the funeral.

PROMOTION.

H. STANLEY ROBINSON, of Chorlton-cum-Hardy, is the R.N.V.R. wireless operator referred to in connection with "A Fisherman's Fight," mentioned on page 456 of our last issue, under "Maritime Wireless Telegraphy." He has now been promoted to a commission as sub-lieutenant, R.N.V.R.

LIFE-SAVING.

The following spontaneous appreciation of the vital assistance rendered by JUNIOR OPERATOR ROBERT WILLIAMS, of Kirkton, Dumfries, has been received by the Marconi International Marine Communication Company, Limited, from a senior engineer of the vessel :—

"Being a member of the crew of H.M.T. —— when she was torpedoed, I should "like to recommend to you the conduct of Wireless Operator Williams, who assisted "the third engineer to a hatch board in the water when the latter was seized with "cramp, and also rendered aid to the donkeyman, who had a disabled arm. Had "it not been for the timely assistance of Mr. Williams, these two men would in all "probability have been drowned."

The parchment of the Royal Humane Society for saving life has been awarded to WIRELESS OPERATOR FREDERICK OGDEN at Aberdeen. Whilst bathing, Miss Jeanette Melvin was seized with cramp, became unconscious, and was being carried out to sea, when Mr. Ogden swam out and rescued her.

The Lord Provost of Aberdeen, in making the presentation, warmly eulogised Mr. Ogden's conduct.

MATRICULATION.

MR. ALEXANDER PETTY, of Marconi's Wireless Telegraph Company, Ltd., has passed 33rd in the second division of the University of London Matriculation Examination, held at the South Western Polytechnic Institute in September last.

AWARDS.

The Military Cross has been conferred on TEMP. SEC. LIEUT. F. L. S. FITZGEORGE, South African Engineers, for conspicuous gallantry and devotion to duty in establishing a wireless station under heavy fire 300 yards from the front line. His station was twice wrecked, but he kept up communication with artillery brigade headquarters. After continuous shelling he withdrew his personnel, but remained himself with the wireless installation, and, though severely wounded in the arm, would not leave until taken away on a stretcher.

CHIEF PETTY OFFICER WIRELESS OPERATOR ABRAHAM OATES has been decorated with the D.S.M. for meritorious conduct. His vessel was torpedoed, but the submarine was subsequently sunk. Oates, who is 28 years of age, joined the Navy when war broke out. Previously he was a clerk at the Liverpool Docks.

CORPORAL H. FEATHER, R.G.A., has won the Military Medal for maintaining wireless communication under heavy fire. He was formerly a Mexborough reporter.

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Company Notes

Amalgamated Wireless (Australasia), Ltd.

THE tenth half-yearly meeting of this Company was held at "Wireless House," Sydney, on August 29th last, the chair being taken by the Hon. Sir Thomas Hughes, M.L.C., Chairman of Directors. The speech delivered by him to the shareholders emphasized the leading points of a very satisfactory balance sheet and report. He deplored the fact that no revenue had been received from wireless telegraph messages during the period under review, although the Company was obliged to maintain a staff for dealing with official ships' messages, which have to be handled free of charge. He dwelt with much satisfaction upon the successful manufacture by the Company of high-class electrical instruments and apparatus, making special reference to the new type of wireless telegraph receiver based upon the Marconi Company's patents, which was produced by the Managing Director, Mr. E. T. Fisk, and which has been successful in picking up messages over a distance of 12,000 miles. Encouraged by the success of the Company's manufacturing department, the Directors have established a subsidiary Company (registered under the title of Australectric, Ltd.) for carrying on this work.

Sir Thomas Hughes also announced the establishment of a branch of the Wireless Press in Australia, destined to become the centre of supply for all authentic publications in England and America dealing with wireless telegraphy and telephony, besides acting as sole agent for the Wireless Press, Ltd., London, and the Wireless Press Inc., New York. This new enterprise is publishing a monthly magazine entitled *Sea, Land and Air*, the first number of which was reviewed in the June issue of THE WIRELESS WORLD, and which shows every sign of attaining wide popularity.

The following is the text of the Directors' Report presented at the meeting:

REVENUE AND DIVIDEND.—Your Directors have pleasure in submitting herewith the Balance Sheet and Profit and Loss Account for the six months ended June 30th, 1918.

The net profits of the business for the half-year amount to £3,650 15s. 9d., which, together with £574 os. 5d. brought forward from last account, leaves a balance of £4,224 16s. 2d. to the credit of Profit and Loss Account.

From the above amount, which is available for distribution, your Directors recommend payment of a dividend for the half-year at the rate of 5 per cent. per annum. This will absorb £3,500, and will leave a balance of £724 16s. 2d., from which your Directors recommend placing £500 to Reserves and carrying forward £224 16s. 2d. to the next account.

Your reserves now stand at £25,305 os. 8d.

SHIPS' MESSAGE TRAFFIC.—During the period under review your business has progressed satisfactorily in every department, except in that of wireless messages, which, as stated in previous reports, bring in no revenue during the war. In spite of the losses from enemy action, the number of vessels equipped with your Company's apparatus is continually increasing.

MANUFACTURING DEPARTMENT.—Your factory is steadily increasing its production of wireless apparatus, and your Directors are pleased to inform you that, as a result of the increased accommodation, plant and staff, the factory output has been greatly augmented during the half-year.

In accordance with the Articles of Association, Messrs. C. P. Bartholomew and James Taylor retire from the Board of Directors; these gentlemen are eligible for re-election, and offer themselves accordingly.

Mr. Alexander Jobson, F.C.P.A., the Company's Auditor, retires in accordance with Article No. 146, and, being eligible, offers himself for re-election.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions, readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (6) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

D. F. (Aberdeen).—The examination for the Postmaster-General's Certificate of Proficiency in Radiotelegraphy calls for a certain degree of skill in telegraphic sending and receiving, a good knowledge of the connections and functions of the instruments used in the system in which the candidate is being examined, ability to trace and clear faults, and a sound acquaintance with the regulations governing the conduct of radiotelegraphic traffic. The standard textbooks for this examination are the *Handbook of Technical Instruction for Wireless Telegraphists* and the *Elementary Principles of Wireless Telegraphy*, both of which you will find advertised in this issue.

2nd A.M. M. (B.E.F.).—The textbook to which you refer, by Dr. Ing. Hans Rein, is known to us, and we have a copy of an earlier edition in our library. It is undoubtedly one of the best of the German manuals, but has not, so far as we know, been translated into English. Dr. Rein, the author, was killed in the war while fighting with his regiment. Very few "wireless" books have been translated from German into English. The two most important translations are Zenneck's treatise on wireless telegraphy—a standard work—and Ruhmer's *Wireless Telephony*, translated by Dr. Erskine Murray. This latter volume is now very much out of date. In reply to your second query, there are several methods of recording wireless signals at high speed. With modern amplifying receivers, signals can be made strong enough to actuate several forms of recorder. One method depends upon the use of an Einthoven galvanometer (see "Digest of Wireless Literature" for November, pp. 437 and 458). Received signals cause a thin wire to uncover a slit, allowing a beam of light to fall upon a moving band of photographic paper. The light acts upon the paper, which is rapidly developed and fixed, the signals showing as long and short black lines upon a white ground. The chief of many disadvantages of this method is that it is almost impossible to differentiate between atmospherics and true signals, and for this reason it is little used. A far more convenient and practical method consists in recording the signals at a high speed upon phonographic wax records, and then running the records so made at a slower speed for "reading up." This method enables atmospherics to be differentiated by sound, and is used to a considerable extent by the Marconi Company. As soon as the "atmospheric" problem is overcome, we may expect important developments in automatic transmission and reception, and it is not too much to expect type printing telegraphs to be adopted for wireless working in the future. The "Lag" and distortion of signals, which is such a hindrance in cable working, is absent in the case of radio signals.

WIRELESS IN THE ROYAL ENGINEERS.—In the October issue we referred a correspondent to Major Handley, at Worcester, for particulars of the Wireless Section (R.E.). We have since been informed that this section was removed some time ago from Worcester to Bedford. All inquiries should therefore be addressed to H.Q., Bedford.

W/O N. M. (Winchester).—The new Order in Council regarding the standard uniform for the Mercantile Marine classes the wireless operators among the officers of the ship (see page 491 of this issue).

"ENQUIRER" (Durban).—Wireless telegraphy on moving trains has not so far been widely adopted. Most of the successful work in this direction has been carried out in the United States, where both radiotelegraphy and radiotelephony have been conducted from certain trains of the Lackawanna Railway and the Union Pacific Railway Company. Considerable success has attended these experiments, and particulars of the Marconi Company's demonstrations on the Lackawanna

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trains appeared in the February, 1914, issue of THE WIRELESS WORLD. A description of the experimental work of the Union Pacific Railway Company appeared in the Proceedings of the Institute of Radio Engineers for August (see page 490 of this issue). We are not acquainted with the apparatus of the inventor to whom you refer. Some work has been done on inductive telegraphy between suspended wires on moving trains and wires laid along the track side, but this, of course, is not "wireless" telegraphy in the generally accepted meaning of the word. This method does not seem to have met with any great success.

We are interested to hear of the form of spark gap you have devised, but do not think it would give a very sharp discharge if used for small wireless transmitters, owing to the semi-conducting nature of the space in the evacuated bulb. We are glad you think the increased number of lines to the page gives no cause for complaint. Other readers have expressed the same view, and, so far, we have had no adverse comments whatever. This change has effected quite a considerable saving in paper without in any way reducing the value of the magazine.

"AMBITION" (B.E.F.).—(1) There is no book published containing details of the particular instrument to which you refer, although there probably exists an official document on the subject. (2) £50. (3) There is no age limit for candidates for the Postmaster-General's Examination. The Marconi Company, whose service most successful candidates enter, has an age limit, however, and in peace time will only accept men between the ages of eighteen and twenty-five.

CAPITAINE DE LA B. (Boulogne S/M).—It is impossible to discuss the respective advantages and disadvantages of the reaction and cascade methods of valve amplification within the confines of this column, quite apart from the fact that the two methods are essentially different and cannot truly be compared. The reaction method is dependent upon the ability of the valve to generate oscillations, whereas the cascade method is dependent upon amplification purely. Censorship restrictions prevent us giving any really useful information upon this point, but we hope to deal with the question fully as soon as conditions will allow.

A. R. F. G.'S. (B.E.F.).—(1) You do not say to whom you wish to explain your invention, but, in any case, the best method is to give as brief an explanation as is commensurate with clearness, followed by diagrams of circuits, and a statement of the points of novelty in your device. (2) A model is not necessary. (3) Taking out a patent is a highly technical matter, and cannot safely be undertaken by an ordinary individual. Any reputable patent agent will handle the whole matter for a fee, which is certainly well spent if the idea is really a good one. Many a good invention has been lost to the inventor by loopholes in the patent specification, which have allowed wholesale infringement with impunity. Your letter reached us after the November issue had gone to press, and thus could not be answered before.

H. A. (Clitheroe).—The prospects of both you and your friend being appointed to the same ship are rather remote, seeing that both would have to serve first as junior operators under experienced seniors, and therefore on different ships. Afterwards, when you gained experience, you would both be appointed officers-in-charge, and therefore would be again on different ships, unless, of course, one of you consented to serve as junior to the other. The chances are very small, however, and, after all, you have not joined the staff yet, so such discussions are rather premature.

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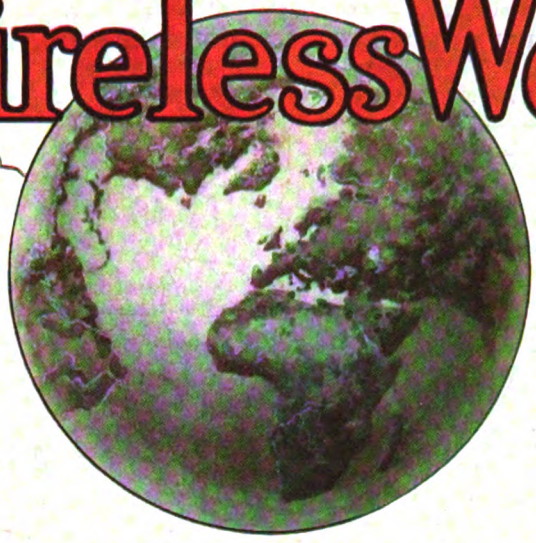

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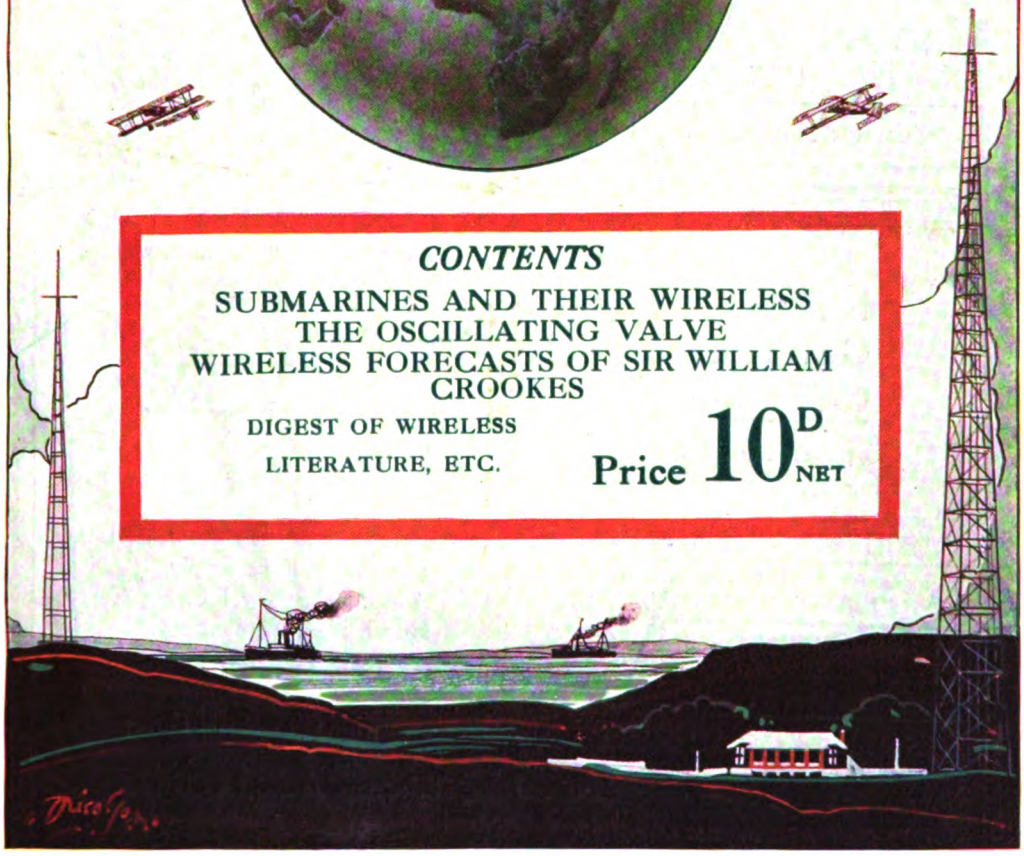

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SUBSCRIPTION RATES.—United Kingdom and British Empire (outside North America), 12s. per annum, post free; United States, Canada, and Newfoundland, $3.00 per annum, post free; and Europe, frs. 15 per annum, post free.

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Articles submitted for acceptance by the Editor (which will be paid for on publication) should be addressed to Marconi House, Strand, London, W.C. *No responsibility can be taken for MSS. or Photographs sent without stamps to defray cost of return postage.*

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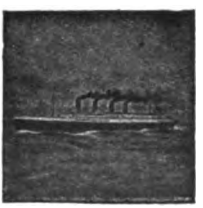

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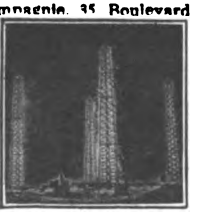

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The
WIRELESS
·WORLD·

Volume VI. No. 70. JANUARY, 1919.

Wireless Aid in Fighting Forest Fires

Special Coach Tours in New Brunswick

By DOUGLAS R. P. COATS

AMONGST the lessons which we have recently learned in abundance, a prominent place must be given to a realisation of the value of wood. Until our struggle against the Germans brought about a shortage of this important article in our little islands, we did not grasp the extent to which wood in peace-time entered into our everyday requirements. In pre-war days this natural product poured into England from all over the world. Many countries contributed their quota, the vast bulk of what we used was brought to us from overseas, and a very small percentage indeed was drawn from our own countryside. We have lived to see Portuguese foresters at work in English woods endeavouring to meet the needs of the critical period of the war from our own resources.

The forest products of Canada have, ever since the country began to be exploited, constituted one of the Dominion's most important sources of wealth. According to he most recent available statistics, the total area of land within her confines

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covered by timber, is estimated at between five and six hundred million acres. Of these vast woods about half rank as commercially valuable. Canadian timber finds its way to all parts of the world—to the United States, to Great Britain and to the Australian Colonies. The Dominion saw-mills are both extensive and well appointed, giving employment to large numbers of men, besides furnishing freight for railways and shipping, so that altogether it will be seen that the prosperity of forest industry looms large in the world of Canadian economics. It is estimated that the total values of the forest products for 1916 amounted to one hundred and ninety million dollars.

We are all of us familiar with the ordinary purpose for which wood is employed, and the tribulations through which we have recently passed in the lack of paper have demonstrated the significance of the gigantic figures attained by the importation of wood pulp. But there are a variety of specialised uses to which particular kinds of wood are put, which do not come within the ken of a large number of us. It is

not, for instance, a matter of universal knowledge that, in certain essential parts of aeroplane construction, spruce has been found immensely more efficient than any metal. Now, the particular species of fir which supplies this wood grows in marketable quantities in but two places in the world—the North Pacific forests and the German Provinces along the Baltic Sea (including a portion of the Russian territory which the Hun recently overran).

The Canadian people have long since realised the high value of their forest lands, and have taken active steps to combat the destructive forest fires which have been responsible, in the past, for wholesale destruction of life and riches. Amongst other agencies for arousing Canadian public interest in the conservation of this source of their national wealth, an important place is taken by the Canadian Forestry Association, an independent body whose membership amounts to about 7,000, all keenly alive to the perils threatening the forests of the Dominion, and determined to overcome the ravages of spruce-bugs, blight, and fire, with the assistance of the most modern methods and appliances. It is true that the Governments of the lumbering provinces maintain small armies of rangers and fire-wardens, engaged in the duty of patrolling the forests and enforcing protective laws. But unless such

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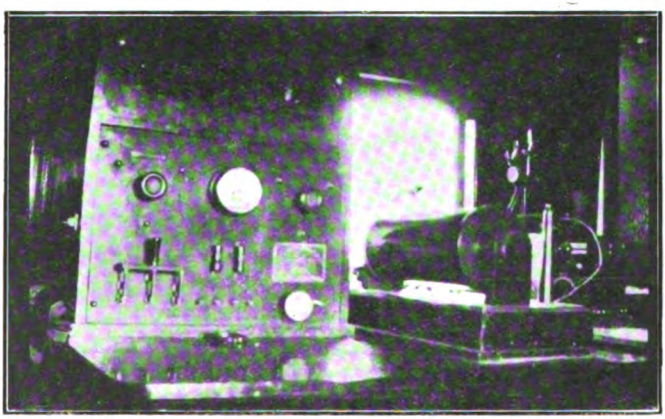
THE EXHIBITION COACH WHICH TOURED THROUGH FOUR PROVINCES.

governmental action be backed, by public opinion, the work of these officials would be sorely hampered; indeed, even as matters stand, the carelessness of ignorant picnickers in failing to damp down their fires, ere they leave their camping places, is responsible for originating large numbers of serious outbreaks.

One of the methods employed by the Canadian Forestry Association to arouse public interest in this connection has been that of collecting material for a general exhibition of forest products, including special exhibits calculated to arouse their interest in the various devices used for combating forest fires. Wireless is destined to play an important part in this warfare against fire, solving as it does the problem of instantaneous communication in these vast lumber districts. Look-out posts have been established in considerable numbers to keep watch from the best points of vantage over the lumber lands, so that as soon as an outbreak occurs information may be immediately transmitted to the proper authorities, who are thus enabled to take such steps as are possible to rush assistance to the spot, to localise the conflagration and extinguish the blaze with the least possible delay. Prompt action is the vital point in such a matter as this. Measures, to be effective, must be taken before the areas affected have become unmanageable, and the only agent which can execute this task satisfactorily is wireless. Wired telegraphy, or telephonic communication, is liable, at any moment, to be rendered useless by the very agency it was intended to combat. Aeroplanes may prove of valuable service in this connection, but here again, for means of communication, reliance must be placed upon the ether waves. The possibilities of an aeroplane forest patrol service were discussed at length in a recent conference of the Forestry Protective Association in Montreal, and experiments are being carried out in British Columbia which may result in the general adoption of the "plane," and the abandonment of the old-fashioned methods of forest protection, through the means, above alluded to, of a system of look-out towers with men maintaining a continual watch over the trees, and linked with head-



THE TRANSMITTING GEAR OF THE WIRELESS INSTALLATION ON THE EXHIBITION TRAIN.

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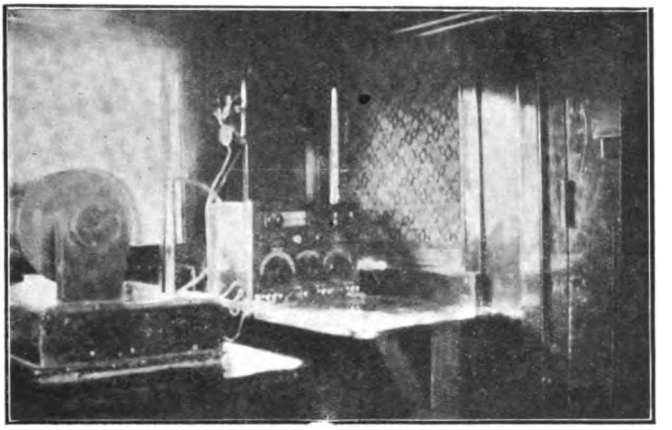
quarters by telephone. A number of difficulties have yet to be overcome, however, before the aeroplane can be used with success for this purpose, the main stumbling block at present being connected with the problem of landing. Whatever may be the outcome of these experiments, there can be no question that the day is at hand when wired telephones, as a means of communication between the observation posts, will be replaced by the more practical and reliable methods of wireless.

The vast character of the evil with which man is faced by fires in these regions may be judged from the figures attendant upon a recent destructive conflagration in Minnesota, when a forest fire got out of hand and swept in destruction across a whole countryside, causing a loss of over a thousand valuable lives, and completely destroying no fewer than twenty-one townships.

Amongst the various schemes originated by the Forestry Association for giving the public that "dig in the ribs" which it frequently so badly needs, was an exhibition arranged in one of the Canadian Pacific Railway Company's coaches, recently sent on a tour through the provinces of Ontario, Quebec, New Brunswick and Nova Scotia. Stops were made at selected centres *en route*, and lectures were delivered to visitors, either in the car itself or in local halls hired for the purpose. Antiquated and modern methods of fighting forest fires were contrasted by moving pictures, whilst the same agency illustrated the complete process of production of a magazine, from the cutting of logs in the primeval forests to the conversion of the "raw material" into pulp and its manufacture into paper, closing finally with the printing stage. One of the exhibits which attracted special attention was a splendidly finished model aeroplane, built to scale in Sitka spruce, the wood so much in recent demand for fighting machines, a species of timber so difficult to obtain in the higher grades required that the preservation from fire of the forests where it grows has become a matter of international importance.



THE RECEIVING GEAR OF THE WIRELESS INSTALLATION ON THE EXHIBITION TRAIN.

On this exhibition train the Marconi Wireless Telegraph Company of Canada installed one of their ¼ kw. outfits, assigning to the present writer the novel work of operating the set, and delivering "talks" on wireless to the audiences who flocked to see our travelling exhibit in the towns visited throughout New Brunswick. Everywhere in this beautiful province the keenest interest was displayed in wireless telegraphy by the local inhabitants, many of whom knew by bitter experience the terrors of a forest fire. The provincial government officials at Fredericton, the capital of New Brunswick, are devoting considerable study to this vital question of forest protection. Colonel Loggie, the Deputy Minister of Lands and Mines, who visited the exhibition in company with the Minister of Agriculture, appeared particularly interested in wireless, and it would not be a matter of surprise for us to find New Brunswick amongst the first Canadian provinces to apply to the safeguard of their woods and forests dwellers the invention which has achieved such astounding results in saving life and property at sea.

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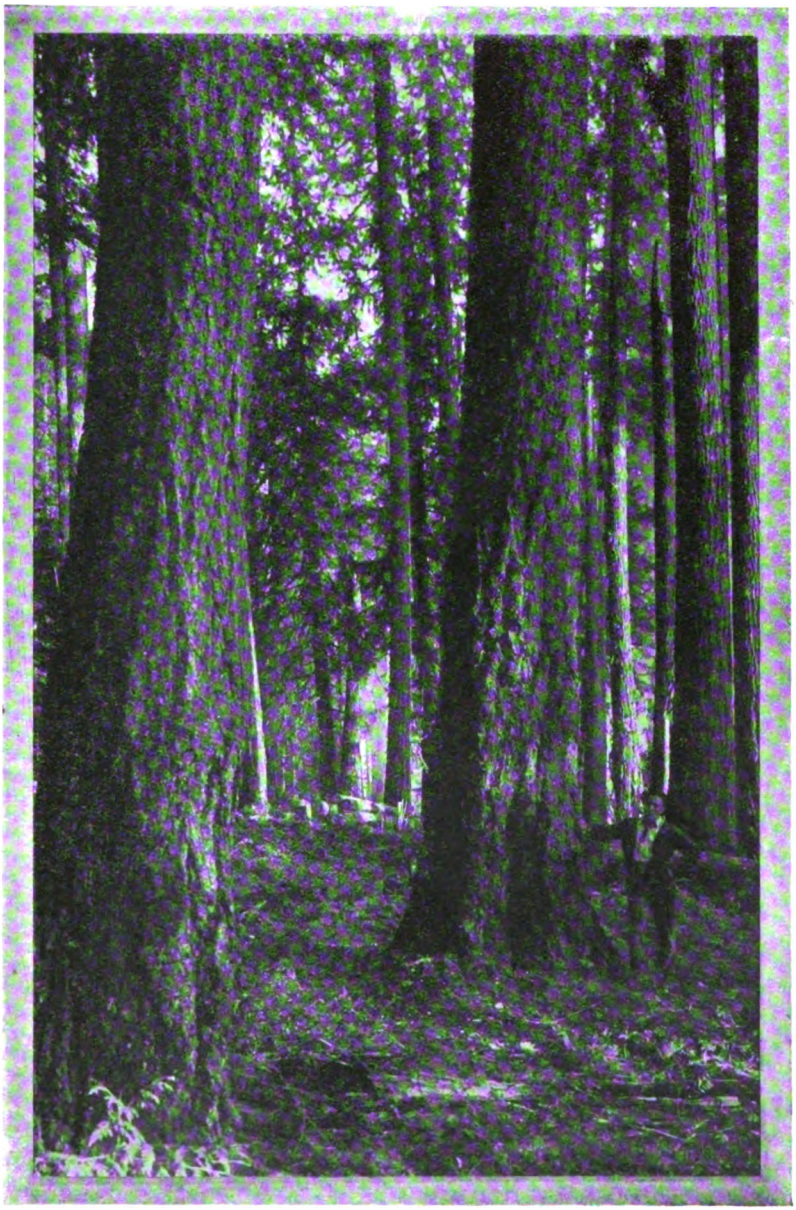

A GROVE OF CANADA'S GIGANTIC TREES.

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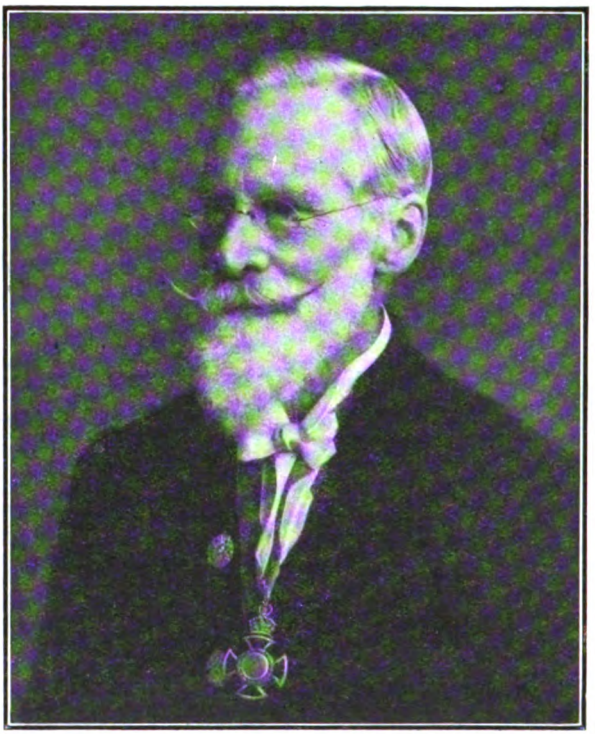
PERSONALITIES IN THE WIRELESS WORLD



SIR WILLIAM CROOKES

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PROPHECY has perhaps seldom been more strikingly fulfilled than in the case of the prognostications of Sir William Crookes with regard to wireless telegraphy, a brief record of which will be found on pages 554–557 of this issue.

Sir William Crookes was born five years before Queen Victoria ascended the throne, and in 1848 entered upon his scientific training at the College of Chemistry under Dr. Hofmann. In 1857 he became a Fellow of the Chemical Society, and five years later was awarded a medal at the International Exhibition for the discovery of a new element, which received the name of thallium. Thus was initiated a long series of discoveries, amongst which may be cited those of the Radiometer in 1875, Radiant Matter in 1879, the Genesis of Elements in 1887, and the Sphinthariscope in 1903. Since 1859 he has been Editor of the *Chemical News*, so that 1919 will mark his sixtieth anniversary in this connection.

His connection with the Royal Society has been both long and distinguished; he became a Fellow in 1863 and won the Royal Medal of the Society in 1875, the Davy Medal in 1888, besides the Copley Medal in 1904. He was enrolled a Member of its Council in 1877, acted as Vice-President in 1885–6 and again in 1907–8. He received the appointment of their Foreign Secretary in 1908–12, and finally filled the supreme office of President between 1913 and 1915. The French Academie des Sciences bestowed upon him their Gold Medal and a prize of 3,000 francs in 1880; whilst in 1885 his invention of the radiometer secured him a Gold Medal at the International Inventions Exhibition. In addition to having filled the Presidential Chair of the Royal Society, he is a Past-President of the British Association of the Society of Chemical Research, and of the Society for Physical Research.

Foreign lands have vied with his Mother Country and her Colonies in doing him honour. His valuable contributions to the advancement of science have been specifically acknowledged in various ways by Argentina, France, Holland, Italy, Mexico, Roumania, and Sweden. He was created a Knight Bachelor in 1897 and has been invested by many eminent foreign and colonial institutions with a number of distinctions and honorary degrees, which include the Elliott-Cresson Medal awarded to him by the Franklin Institute (Philadelphia) in 1912.

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The Oscillating Valve

By E. V. APPLETON, M.A., B.Sc., R.E.

THE necessary conditions for the performance of any of the functions of a double-anode valve may be derived from the experimentally determined relations between the following quantities: Plate voltage, plate current, grid voltage, grid current, and filament temperature. Let the values of these quantities be denoted by V, I, v, i, and θ respectively. Simple experiments yield the relations which obtain between them.

The most important relation is that between V, I, and v when the filament temperature is kept constant. This relation is represented graphically for a typical hard valve by the curves of Fig. 1, which are termed the static characteristics of the valve in question. It is the aim of this article to show how the conditions required for the production of continuous electrical oscillations by any three-electrode valve can be foretold from its static characteristics.

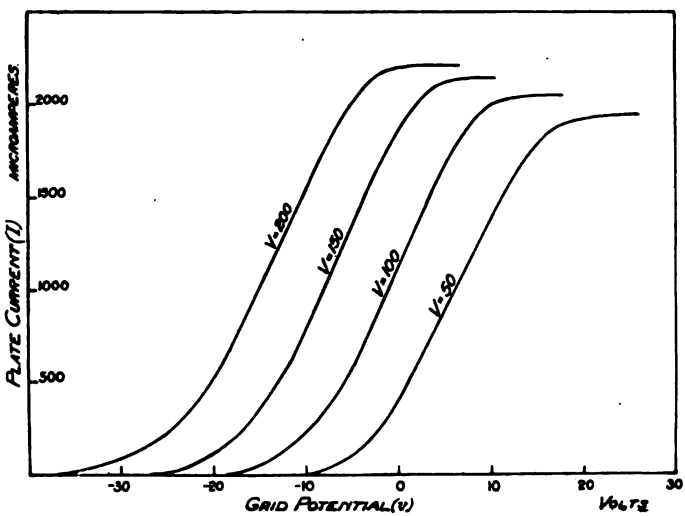

FIG. 1.

From Fig. 1 it is clear that $I=f(V, v)$.

Langmuir,* assuming that the space charge effect is the main factor tending to discourage the flow of electrons from filament to plate, has shown that for the middle parts of the curves we may write this more definitely as $I=A(V+Bv)^{\frac{3}{2}}$ where A and B are constants. This expression is rather unwieldy for mathematical work, and a simpler one has been suggested by Vallauri,† who proposes to consider the straighter parts of the characteristics as approximately parallel straight lines. This means that the characteristic surface may be regarded as approximately plane, and may be expressed by the relation $I=av+bV+c$, where a, b, and c are constants. This expression will be used in all the subsequent mathematical work in this article.

In most oscillating valve circuits some external coupling is necessary between the grid or control circuit and the anode or plate circuit. Either electromagnetic or electrostatic coupling may be employed, the former, however, being more commonly used. Fig. 2 represents two typical circuits with electromagnetic linkage.

In circuit (α) the oscillating circuit is in the plate circuit while the reaction coil (l) is connected to the grid. In circuit (β) these positions are reversed. The

* Langmuir, *Proc. Rad. Eng.*, Sept. 1915. † Vallauri, *L'Elettrotecnica*, Nos. 3 and 4, 1917.

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frequency of the oscillations generated is determined largely by the inductance and capacity values of the oscillatory circuit.

Circuit (α) has been dealt with experimentally and mathematically by Vallauri, who has shown that the conditions under which the largest oscillations are produced coincide with the conditions of greatest amplifying power. This fact is illustrated by Fig. 3, which shows the values of oscillatory current obtained is an oscillating circuit when the grid of the valve is maintained at various voltages. The static characteristic for the particular value of plate voltage is also shown. It is clear that the highest values of oscillatory current are obtained when the valve is maintained at conditions represented by the steep parts of the characteristic. The curve also shows that the oscillations begin abruptly and end abruptly at particular values of grid voltage.

The value of mutual inductance required for the production of infinitesimal

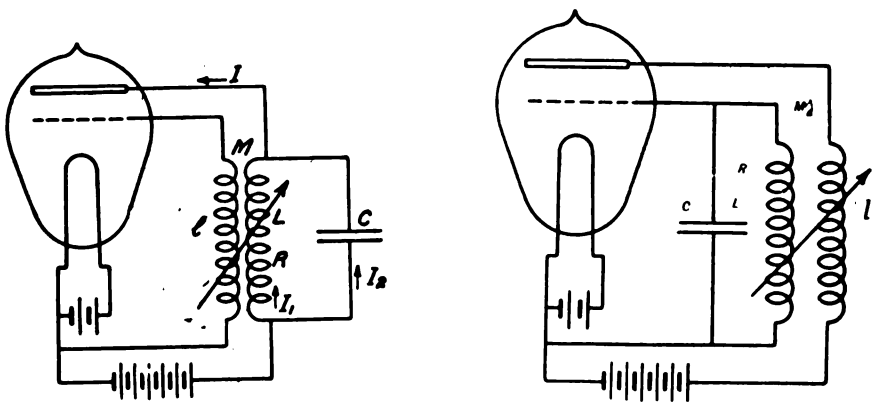

FIG. 2. R^1 IS BATTERY RESISTANCE.

oscillations can be deduced using the equation $I=av+bV+c$. Embodying this, Kirchhoff's equations for circuit (α) become:

$$I=a\left(v-M\frac{dI_1}{dt}\right)+b\left(V-IR^1-L\frac{dI_1}{dt}-RI_1\right)+c \quad . \quad . \quad . \quad (1)$$

$$L\frac{d^2I_1}{dt^2}+R\frac{dI_1}{dt}=\frac{I_2}{C} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$I=I_1+I_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

These equations yield an oscillatory solution with zero damping when:

$$M=-\frac{bL+(1+bR^1)RC}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

producing oscillations in such a case of frequency n where:

$$\frac{1}{n}=2\pi\sqrt{CL\times\frac{1+bR^1}{1+bR^1+bR}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which reduces to $\frac{1}{n}=2\pi\sqrt{CL}$, when R is small.

(For the significance of R, C, and R^1 see (α), Fig. 2.)

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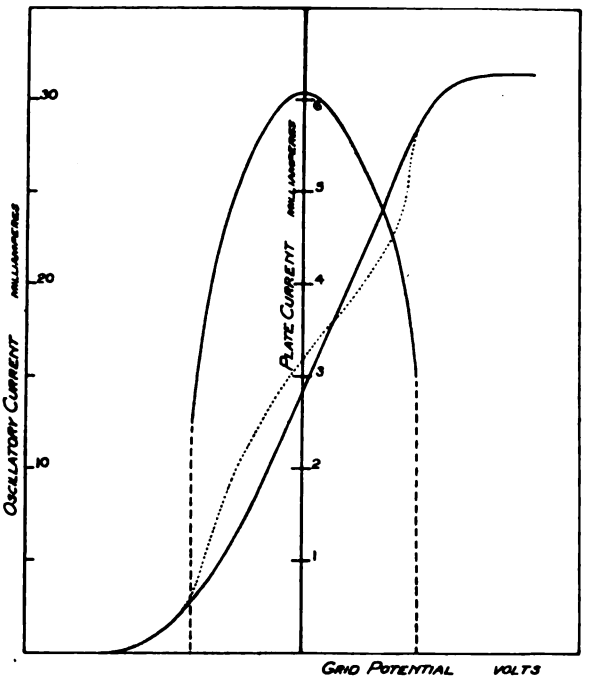

FIG. 3.

Now the parameter a is the slope of the grid voltage-plate current characteristic, and b is the slope of the plate voltage-plate current characteristic. Thus the oscillations are the most easily set up when the curves of Fig. 1 are steep and close together.

From the formula (4) it is clear that a particular value of mutual inductance between grid and plate circuits is required for the production of persistent oscillations. If M has a value numerically less than this amount the resistance effect in the oscillatory circuit is not neutralised and the oscillations are damped. If M is greater than the value demanded by (4) the damping of the oscillatory circuit is negative and the oscillations tend to increase indefinitely. However, when the grid voltage changes are large enough to cause the plate current to reach saturation and zero values no further increase of oscillatory current can be produced by increasing M. This is illustrated by Fig. 4, which shows the relation between oscillatory current and mutual inductance for a circuit similar to (α', Fig. 2. This curve also shows that if the coupling is increased over a certain amount the oscillatory current decreases slightly.

The present writer has shown* that the essential mathematical result of Vallauri can be obtained in a manner which is less mathematical and which makes clearer the physical processes involved.

Consider an oscillation started in the LC circuit of Fig. 5. Every time the point A is positive with respect to B the plate current is increased and a number of electrons flows into the upper plate of the condenser. These electrons tend to neutralise the positive charge which at that instant is residing there: thus the natural damping of the oscillatory circuit (due to

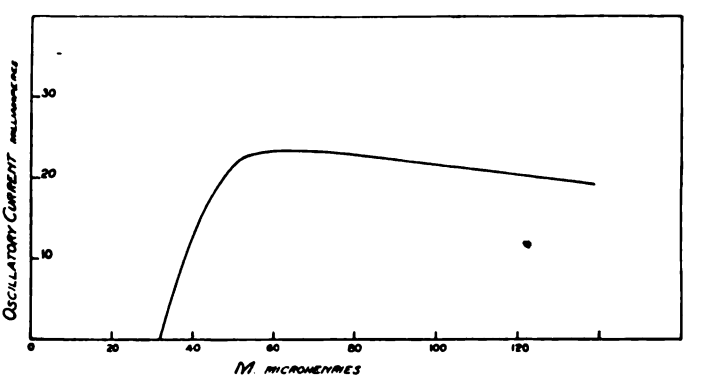

FIG. 4.

* *Electrician*, December, 1918.

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resistance, etc.) is increased. If, however, a tube could be arranged which produces the opposite effect—that is, the plate current is decreased when the oscillation makes A positive with respect to B—the result would be to tend to neutralise the natural damping of the oscillatory circuit, bringing about the possibility of producing persistent oscillations.

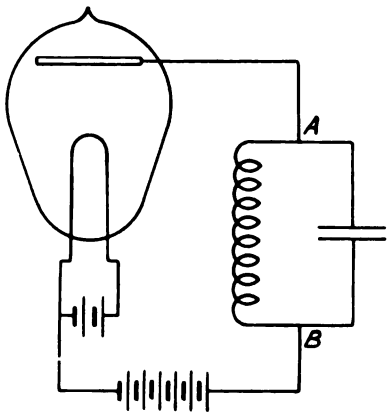

FIG. 5.

It is clear that stating this condition is tantamount to saying that the tube must possess a negative resistance. A. W. Hull has produced such a tube, which is known as the Dynatron (see THE WIRELESS WORLD, June, 1918), and has shown that the value of the resistance required for persistent oscillations is $-\frac{L}{CR}$. With such a tube, of course, no reaction coil is necessary. With an ordinary three-electrode valve the reaction coil brings about the same result.

Let us assume that a feeble oscillation exists in the LC circuit and that the voltage produced by it between A and B is $V \sin \frac{t}{\sqrt{LC}}$. The alteration in plate current produced by this will be $bV \sin \frac{t}{\sqrt{LC}}$. Now, for such a voltage the oscillatory current is at any instant $\sqrt{\frac{C}{L}}\, V \cos \frac{t}{\sqrt{LC}}$.

If we now assume the grid circuit to be activated by electromagnetic induction in the ordinary way* the value of the E.M.F. induced in it will be

$$-M \frac{d}{dt}\left(\sqrt{\frac{C}{L}}\, V \cos \frac{t}{\sqrt{CL}}\right).$$

This E.M.F. will bring about an alteration in plate current of value

$$\frac{aM}{L} V \sin \frac{t}{\sqrt{LC}}.$$

Thus for a voltage change of $V \sin \frac{t}{\sqrt{LC}}$ the resultant current change will be

$$\left(\frac{aM}{L} + b\right) V \sin \frac{t}{\sqrt{LC}}.$$

This means that the effective resistance of the tube when the grid is activated is

$$\frac{1}{\left(\frac{aM}{L} + b\right)}.$$

Thus, for persistent oscillations we must have :

$$\frac{aM}{L} + b = -\frac{CR}{L}$$

—*i.e.*,

$$M = -\left(\frac{bL + CR}{a}\right),$$

which is the same result as Vallauri's for practical cases where bR^1 (see Fig. 2, α) is small compared with unity.

* E.g., see Fig. 2, (α).

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Fig. 6 shows the phase relations between the various quantities involved.

The above investigations have been made on the assumption that the grid currents involved are negligible. In practical work the high plate voltages used make them practically so. Bethenod * has worked out fully the conditions for infinitesimal oscillations allowing for appreciable grid currents and finds that M must conform with the equation :

$$\frac{M^2n}{L}+(a+m)\,M+RC+bL=0 \quad . \quad . \quad . \quad . \quad (6)$$

Here the letters have the same significance as before and m and n are the slopes of the plate voltage-grid current and grid voltage-grid current characteristics respectively.

It is obvious from the nature of the valve characteristic that if the induced voltage in the grid circuit is sufficient to bring the plate current to saturation and zero values a sinusoidal grid voltage change will result in flat-topped plate current variations. Now a flat-topped wave when analysed in a Fourier series is found to contain harmonics, particularly odd ones, and if such an oscillation circuit is used for transmission these harmonics will be radiated.

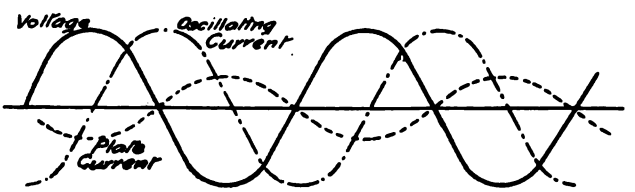

FIG. 6.

It is evident that the existence of these means a loss of efficiency, since only one of the wave-lengths radiated can be used at one time by a receiving station.

If the changes of plate current take place about an operating point which is not half-way up the characteristic the mean value of the plate current (when the valve is oscillating and the saturation and zero values of the plate current are almost being reached) will depart from the normal value. If the operating point is below the centre of the characteristic the mean plate current will increase when oscillations commence, but if it is above the centre the mean plate current as read by an ordinary D.C. galvanometer is reduced.

The actual values of mean plate current for a circuit such as that depicted in Fig. 2 (α) are shown by the dotted line graph of Fig. 3.

The circuit shown in Fig. 2 (β) has not been dealt with by Vallauri, although it is a well-known oscillatory receiving circuit. If the coupling between the plate and grid circuits is over a certain amount the plate current variations induce E.M.F. variations in the oscillatory circuit and the resistance losses are neutralised.

An approximate value of the mutual inductance required can be obtained as follows :

Let Q be the charge of the condenser at any instant.

Then we have by Kirchhoff's equation :

$$L\frac{d^2Q}{dt^2}+R\frac{dQ}{dt}+M\frac{dI}{dt}+\frac{Q}{C}=0 \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Now at this instant the plate current, I, will have a value given by

$$I\,(1+bR^1)=a\,\frac{Q}{C}+bV+C.$$

$$\therefore \quad (1+bR^1)\,\frac{dI}{dt}=\frac{a}{C}\frac{dQ}{dt} \quad . \quad . \quad . \quad . \quad (8)$$

* Bethenod. *La Lumière Electrique*, October 14th, 1916.

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Substituting now in (7) we have:

$$L\frac{d^2Q}{dt^2}+\left(R+\frac{aM}{C(1+bR^1)}\right)\frac{dQ}{dt}+\frac{Q}{C}=0 \quad . \quad . \quad . \quad (9)$$

Thus, an undamped oscillation is obtained in the L.C. circuit when the coefficient of $\frac{dQ}{dt}$ is zero—*i.e.*,

when $$M=-\frac{CR(1+bR^1)}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

In all the above work a consistent set of units—*e.g.*, volt, ampère, ohm, coulomb, henry, and farad—is assumed.

Welcome to the American President

On December 4th last President Wilson left New York, *en route* to Europe, to take part in the Peace Conference, perhaps the most important which the world has ever seen. The late titanic struggle and its aftermath have presented a long series of novel precedents, not the least amongst them being an official visit paid to Europe by the President of the United States during his term of office.

One curious feature in connection with his voyage is that it should have been made on a vessel constructed by the North German Lloyd in pre-war days, and named after the famous American patriot, with the view of propitiating Cousin Jonathan and inducing his citizens to travel on board her. In this particular object, at all events, the German shipping magnates have succeeded beyond their wildest dreams. President Wilson had a grand send-off. He started in glorious weather, and the spectacle of the great liner, flying the Presidential flag, as it steamed down the bay and joined the waiting escort of American warships constituted a brilliant spectacle worthy of the occasion.

We have seen a statement made in the general Press that the steamer is fitted with an especially powerful wireless installation; but we have, up to the present, not succeeded in finding any satisfactory grounds for the allegation. Her original German wireless set was the ordinary TK 1 kw. with an estimated normal range of 250 miles. It is, however, quite likely that since the Americans took her over they have installed fresh apparatus, of—it may be—greater power.

In any case, we notice that the President kept in continual touch with official business by means of radiotelegraphy all through his voyage, and even utilised the aerials of the *George Washington* to nominate a new Secretary of the Treasury in place of Mr. McAdbo. A number of messages to other nations were radiated in the same way, and the Paris Press gave publicity to a wireless message emphasising the long years of penitence that will be necessary for Germany before any true American could think of holding out the hand of friendship, or of paying her a visit.

Arrangements have been made in Mr. Wilson's temporary home in Paris whereby, through the famous Eiffel Tower station, he will be kept in direct communication with Washington. War-time brought wireless into the forefront of national intercommunication, and there are plain indications that peace-time will confirm and strengthen this position.

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Digest of Wireless Literature

"The Theory of Thermionic Amplifiers." *

In the introductory part of the article the author discusses the case of a valve with two electrodes. It is pointed out that Richardson's equation is derived under the assumption of both cathode and anode being equipotential surfaces. The practical case of a filamentary cathode is met by W. Wilson's equation, which is stated. All theoretical equations, however, presuppose a pure electronic discharge. In practice one has to take into account the inevitable presence of residual gas, which leads to larger values of current than those obtained from the equations.

Next the case of an amplifying valve is taken up.

Denoting the potential applied to the plate by E_b, the stray field between grid and filament can be expressed by

$$E_s = \frac{1}{\mu_0} E_b + \varepsilon \qquad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where μ_0 is a constant always greater than unity. Its value will depend on the construction of the valve. In general μ_0 is the larger, the finer the mesh is made. ε is also a constant, the numerical value of which is usually comparatively very small.

The physical meaning of E_s is clear: it is the force which drags a certain portion of the electrons emitted from the filament *through* the grid.

Let us now apply to the grid a potential E_c. If this potential is positive a certain number of electrons will be absorbed into the grid. If E_c is made negative and its absolute value larger than or equal to E_s (which is always positive, since E_b is assumed positive), all electrons will be repelled from the grid, and none of them will reach the plate. In order that electrons should reach the plate we must then have $E_s + E_c > 0$—that is to say, if E_c is negative, its absolute value must be smaller than that of E_s. In the last case no electrons get into the grid, although a certain number of them pass through it. The impedance of the grid circuit can therefore be considered as infinite.

We have seen that the number of electrons reaching the plate, or, in other words, the value of the plate current, will depend on the value of $E_s + E_c$. From experimental results, the author expresses this functional relation by means of the equation:

$$I = \alpha (E_s + E_c)^2$$

where I is the plate current and α is a constant for a given valve.

With the aid of (1) we can write the last equation in the form:

$$I = \alpha \left(\frac{1}{\mu_0} E_b + E_c + \varepsilon \right)^2 \qquad . \quad . \quad . \quad . \quad . \quad (2)$$

which can be presented graphically either by an I, E_b curve (if E_c is kept constant) or by an I, E_c curve (if E_b is kept constant).

* "The Theory of Thermionic Amplifiers," by H. J. Van Der Bijl, *The Physical Review*, 2nd Series, vol. xii., No. 3, September, 1918.

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In order to evaluate the three constants we may proceed as follows.* Let us keep I constant for all variations of E_b and E_c, then we must obviously have:

$$\frac{I}{\mu_0} E_b + E_c + \varepsilon = C \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

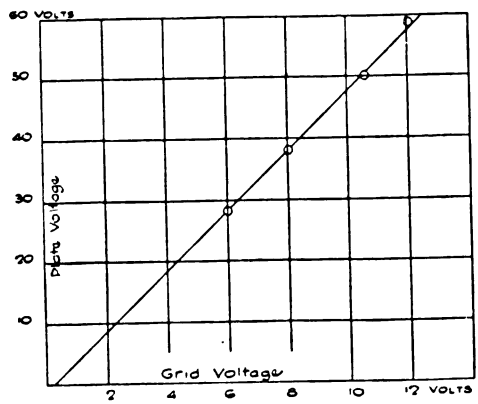
where C is a constant. If we choose $C=0$, we shall have to keep $I=0$. Now the last equation represents a straight line, and it will, therefore, be sufficient to find two points. We may proceed in the following manner: we fix a certain value for E_b and choose E_c in such a way as to make I equal to zero or some other prescribed value. This will determine one point. By repeating the same process for another value of E_c (with the same value of I, however) another point, and, therefore, the whole straight line, can be determined. We may, of course, if desirable, determine the constants analytically in the following manner: let E_{b1} and E_{c1} denote the values of E_b and E_c for the first adjustment and by E_{b2} and E_{c2} the corresponding values for the second adjustment, then:

$$\frac{I}{\mu_0}(E_{b1} - E_{b2}) + (E_{c1} - E_{c2}) = 0,$$

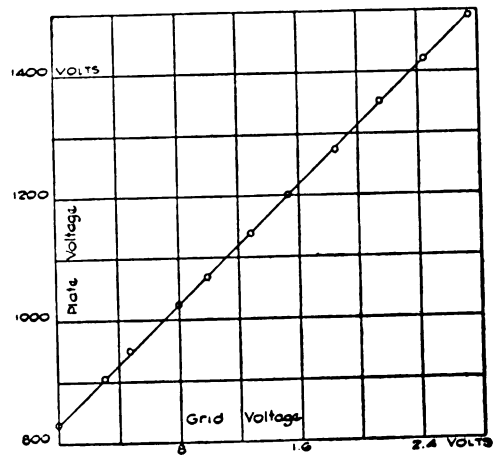
and

$$\mu_0 = -\frac{E_{b1} - E_{b2}}{E_{c1} - E_{c2}}$$

Inserting this value of μ_0 into (3) we can determine ε. Figs. 1 and 2 show the experimental curves obtained by the author for certain types of valves.



Grid voltage negative
$I=0$; $\mu_0=5$.
FIG. 1.



Grid voltage negative
$I=60\cdot10^{-6}$ amp.; $\mu_0=241$.
FIG. 2.

The fundamental equation (2) gives also an easy method for determining the internal impedance of the valve. For this purpose we have got to keep in mind that the slope of the (I, E_b) curve at any point gives the value of $\frac{I}{R_0}$ (where R_0 is the internal impedance of the valve).† Now the slope of the curve can be obtained

* We adopt here a mathematical treatment which is not quite so general as the one given by the author.

† It is assumed that resistance of the external circuit is zero.

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in the usual way by finding $\frac{\delta I}{\delta E_b}$, therefore the average value of $\frac{I}{R_0}$ during a cyclical variation is given by

$$\frac{I}{R_0}=\frac{1}{2\pi}\int_0^{2\pi}\frac{\delta I}{\delta E_b}\,dt=\frac{2\alpha}{\mu_0}\left(\frac{I}{\mu_0}E_b+E_c+\varepsilon\right),$$

whence

$$R_0=\frac{\mu_0}{2\alpha\left(\frac{I}{\mu_0}E_b+E_c+\varepsilon\right)} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Should, however, the external circuit contain a resistance, R, we can easily transform our equation (2) to include that case also by substituting $E_b=E-RI$, where E is the constant voltage of the source in the external circuit. We then obtain

$$I=\alpha\left[\frac{I}{\mu_0}(E-RI)+E_c+\varepsilon\right]^2 \quad . \quad . \quad . \quad . \quad (2^1)$$

From the last equation we obtain

$$\frac{dI}{dE_c}=\frac{\delta I}{\delta E_b}\cdot\frac{dE_b}{dE_c}+\frac{\delta I}{\delta E_c}=2\alpha\left(\frac{I}{\mu_0}E_b+E_c+\varepsilon\right)\left(1-\frac{R}{\mu_0}\frac{dI}{dE_c}\right)$$

whence

$$\frac{dI}{dE_c}=\frac{2\alpha\left(\frac{I}{\mu_0}E_b+E_c+\varepsilon\right)}{1+\frac{2R\alpha}{\mu_0}\left(\frac{I}{\mu_0}E_b+E_c+\varepsilon\right)}$$

which can be written with the aid of (4) in the form :

$$\frac{dI}{dE_c}=\frac{\mu_0/R_0}{1+R/R_0}=\mu_0\frac{I}{R+R_0}$$

Multiplying both sides of last equation by R, we obtain

$$\frac{RdI}{dE_c}=\mu_0\frac{R}{R+R_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now RdI is the change of voltage across the resistance R, inserted in the plate circuit, caused by a change dE_c in the voltage applied to the grid. Therefore the ratio $\frac{RdI}{dE_c}$ expresses the *voltage amplification*. We see, then, that this amplification is always smaller than μ_0 and approximates that value when the external resistance is very large in comparison with the internal resistance of the valve.

The author discusses further the question of current and power amplification. Since the current in the grid circuit is either zero or negligibly small, these amplification ratios become indeterminate. An artificial method had, therefore, to be employed.

In conclusion an experimental verification of the various results, obtained theoretically, is given.

A NEW TECHNICAL COURSE in Wireless has been established by the Portsmouth Education Committee at the Municipal College. The training of wireless operators will be undertaken as a part of the regular work of the College, and the course will extend generally over two years, the first being devoted to general electrical engineering, the second to wireless telegraphy, etc. All boys joining under 16 years of age must attend the full two-years course unless already qualified in the first-year subjects. The fee will be £5 5s. per annum.

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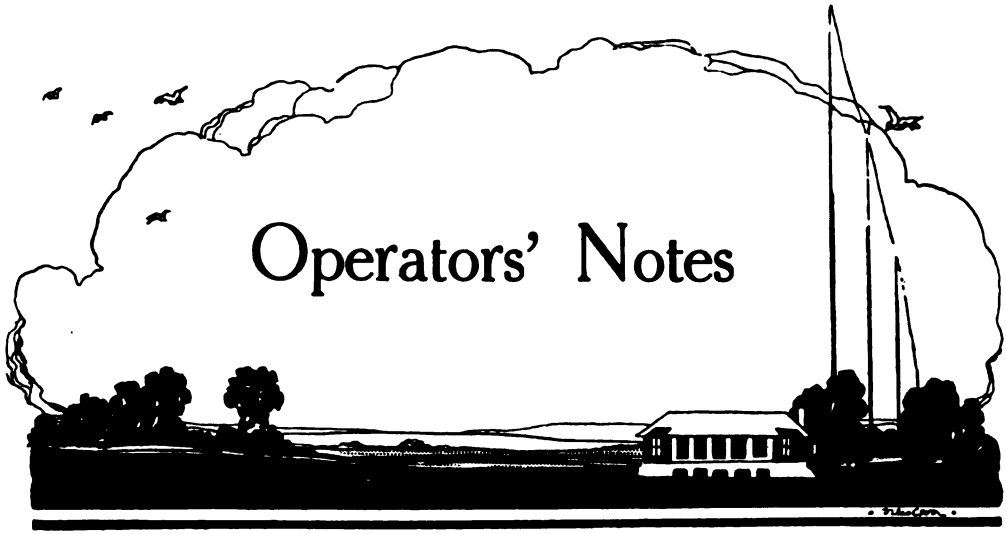

Operators' Notes

Time Signals.

THE efficient navigation of a vessel depends entirely upon the possibility of being able to prick off her position accurately on the chart, and so enabling the master to reduce the distance run between ports to the minimum consistent with perfect security. In determining a vessel's position when out of sight of land latitude is calculated by the aid of sights taken with the sextant, but longitude can only be accurately determined provided that the vessel's chronometers are either keeping perfect time or have a known error. However, the most modern chronometers are liable to vary a few seconds per day, and an unsuspected error of one second might cause the vessel's position to be pricked off about a quarter of a mile east or west of her true position. In the case of a vessel approaching the land in thick weather after some days without sighting land, the accumulated error might possibly result in disaster, and the master of a vessel would in such circumstances follow a course which would give the land a wide berth, a proceeding, unfortunately, which would result in lengthening the distance run (consequently increasing coal consumption and other expenses), and also the time taken on the voyage.

One of the most valued direct aids to navigation is provided by the time signals transmitted from various land stations at certain hours, so that it is possible in nearly all parts of the world to determine the error of a chronometer by means of making comparisons between it and the time signals received.

Full particulars of the stations from which time signals are transmitted are to be found in the *Year-Book of Wireless Telegraphy*, pages 905–927.

In order to take full advantage of these signals the operator must be capable of tuning them in rapidly and accurately, especially as it is, of course, frequently necessary to pick up the signals at a great distance. It is not sufficient merely to obtain readable signals, but every effort must be made to increase their strength, thus enabling some method of reducing atmospherics and jamming to be adopted, such as using minimum coupling. It is obvious that time signals (which are usually a series of dots) could not be absolutely relied upon if received through interference, more especially owing to the fact that the operator has to "relay" the signals to the navigating officer, and therefore his attention cannot be wholly concentrated on the work of reception.

The wave-length of time signals transmitted from the various stations is given in the *Year-Book*, and the writer found it extremely useful to compile a chart having

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columns for date, time, name of station transmitting, wave-length, distance, strength of signals, ATI and Billi condenser adjustment, etc.

As the wireless telegraph apparatus is never installed in the Chart Room, where the ship's chronometers are kept, and as it would be extremely inadvisable for the chronometer to be carried to the Wireless Room in order to compare its time with the signals received, it is necessary for a method to be evolved whereby the received signals can be "relayed" to the master or navigating officer without incurring a delay of more than half a second. The signals themselves, owing to "lag" in the working of relays, etc., used at the transmitting stations, might have an error of as much as one-fifth of a second, which error, however, can be disregarded.

The method of communicating the received signals to the Chart Room will depend to a great extent upon the relative positions of the Wireless and Chart Rooms, but as the majority of vessels have telephonic communication between these two rooms, there is, in vessels so equipped, no difficulty in re-transmitting the signals as they are received. The best method, making use of the telephone installation, is for the operator to place the telephone transmitter (in the Wireless Room) on the bench, or within very easy reach, the telephone receiver in the Chart Room being held by the navigating officer, who would be standing in front of the open chronometer. As the time signals are heard the operator should tap the telephone transmitter sharply with a pencil, which would give a sharp, clearly defined sound in the telephone receiver in the Chart Room. Whenever it is necessary for the operator to "tap" the signals, either on the telephone transmitter, on the bench, or on the bulkhead, he should always be seated comfortably, as otherwise a slight movement of the ship may cause him to tap prematurely or too late, which would confuse the officer who was noting the chronometer time.

If the Wireless Room adjoin the Chart Room a good method is for the operator to tap the bulkhead as he receives the signals, but if it be possible, the best method would be to lengthen the double headgear telephone lead, so that the operator, while actually receiving the signals, would at the same time be noting the corresponding chronometer time, and noting the error, if any.

The problem is rather more complicated when the Wireless Room is some distance from the Chart Room, and there is no telephonic communication between the two. If there be an uninterrupted view from the bridge to the Wireless Room, one method is to make visible signals corresponding to the time signals.

During daylight, for example, a small flag might be so arranged at the Wireless Room that on the receipt of each dot of the time signals the operator could cause it to drop. At night a portable lamp could be used, having a Morse key inserted in series for the operator to tap in a manner corresponding to the signals received. In the majority of cases, however, visible signals would be entirely unsuitable in bad weather, and in any case would involve the "relaying" of signals at the chart-house door, consequently the total error might be considerable.

In ships where the Wireless Room is some distance from the Chart Room, and no telephone system is fitted, it is more usual for an officer to be in the Wireless Room to set a stop-watch by the time signals. The stop-watch is then taken to the chronometer, and the error noted. This, however, is not an entirely satisfactory method, and in such vessels it would be advantageous for the master to authorise the running of a twin lead-covered or armoured lead from the Wireless to the Chart Room, which could be used either for "house" telephones or buzzer and key. When wire communication exists between the two rooms the master could make arrangements making it possible for the wireless telegraph receiver to be quickly connected (and disconnected) to the "line" instead of to the receiving phones, which would be connected to the "line" at the Chart Room end. This could easily be arranged by the use of small terminal boards, and by its use errors would be reduced to an absolute minimum, thus enabling the master to place the fullest confidence in this invaluable development of the utility of wireless telegraphy.

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Submarines and their Wireless

Some Personal Experiences of a Radio Engineer

By S. C. ANSELMI

In the middle of the great European war, a comrade in the Wireless Service and I were sent out to the Iberian Peninsula to fit certain units of the Spanish Navy with wireless. Our numerous, varied and interesting adventures had commenced long before we actually arrived at Cartagena, our place of destination.

This port forms one of Spain's principal naval bases and possesses as magnificent a natural harbour as can be found along the whole of the littoral. I had diversified my voyaging at sea by trips on all sorts of vessels—battleships, gunboats, destroyers, torpedo boats—and had become very keen on travelling in a submarine.

Spain claims to be one of the first nations to have produced a submarine vessel moved by electric power, albeit that during the lifetime of Isaac Peral, the naval engineer, upon whose achievements she bases her claim, the pioneer's efforts were treated with contempt, and his desire to enhance the prestige of his country was frustrated. What Isaac Peral accomplished was to design and construct, at his own private expense, a small submersible boat propelled when under water by an electric motor and storage battery. Now that the recent struggle has demonstrated the potentialities of these under-water craft, Peral's countrymen are desirous of letting all the world know their claims to be first in the field.

At the beginning of 1917 there was not a single submarine in the Spanish Fleet, and the first instalment of this new sea arm was constructed in the U.S.A. and crossed the Altantic by its own power. Great was the flutter of expectation all over the Peninsula when the news arrived that this vessel, named *Isaac Peral,* after Spain's first submarine engineer, was on its way to Cartagena. Just before reaching the Canary Islands, however, a rather serious mishap occurred, involving lengthy repairs in Las Palmas; the delay damped down public enthusiasm, and put a stop to the demonstrations with which it had been arranged to herald its arrival.

As soon as the *Isaac Peral* reached Cartagena, I went on board and found her to be a vessel displacing about 500 tons and fitted—so far as wireless telegraphy is concerned—with a single ½ kw. American Marconi panel set. The aerial, of a T-shape with sloping down extensions composed of two wires, was upheld by a single mast about 25 feet high. It possesses a reliable range of about 100 miles. I found that this under-water boat was, in addition to wireless, fitted with Fessenden's submarine signalling apparatus. It was my privilege to witness many interesting evolutions of this craft, and some of the accompanying illustrations are reproductions of photographs taken during a diving trial.

In August, 1917, a small flotilla of three submarines purchased from the Italian Government reached Cartagena. They had been built in Spezzia. I watched these three Italian vessels as they came in, from the deck of a Spanish torpedo boat, and it was a really wonderful sight to see the ease with which they manœuvred as they entered the naval yard and swung round to their mooring places. A few days later I received orders to place myself at the disposal of the commander of the flotilla, as the wireless sets on board required some modifications. My ambition for submarine voyaging was to be fulfilled! I made a dash for the *A.1.* and quickly disappeared down her hatchway. I found the commander of the boat in overalls superintending some engine repairs, explained the object of my visit, and was taken round the ship on a tour of inspection, leaving the wireless installation to the last.

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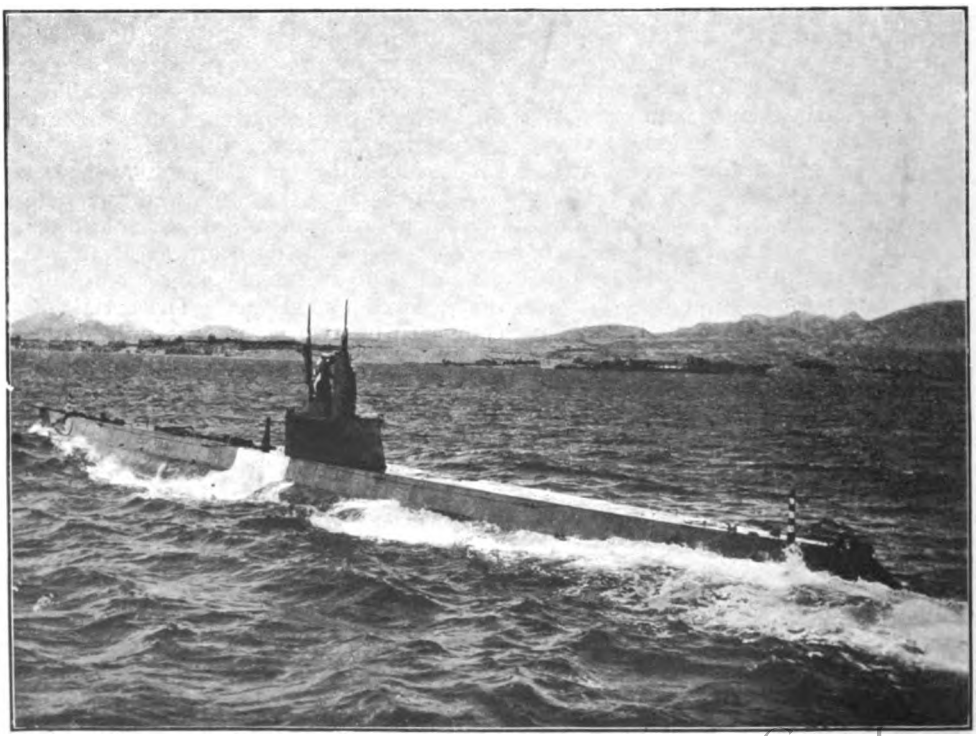
I found the latter to consist of a ½ kw. Marconi standard ship station set, completely enclosed in a cupboard located immediately abaft the engine room. In my opinion, such an arrangement was far from ideal, as wireless tests were almost impracticable when the Diesel engines were running, as the noise made by the two 600 h.p. engines was simply deafening, despite the closing of the watertight door between the engine room and the after part of the vessel. Even the most experienced wireless ear would have found it difficult under such conditions to pick up any signals from a 3 kw. station not twenty miles away. The transmitter consisted of the regular ½ kw. converter and synchronous disc-discharger mounted on a shaft extension; the transformer, condensers, chokes, etc., being of the usual type. Space-saving had been carried too far, and I found that all the parts were so closely mounted as to render inspection extremely difficult. The receiving part of the installation consisted of the magnetic detector and tuner. These I replaced by an opposed-crystal receiver, which gave considerably more efficient results. On these vessels, owing to lack of elbow room, all the operating had to be conducted, not sitting but standing, a very awkward arrangement if there be much traffic to handle. This state of affairs, however, did not prevail during my stay on board. These Italian submarines carry a T-shaped aerial mounted on a mast about the same height as that of the *Isaac Peral*, and when the boat is ready to submerge this mast has to be taken down from its socket and the aerial wires coiled up, whilst the leading-in insulator must be removed and replaced by a water-tight cover.

The pressure on a submarine when submerged at any depth becomes severe and every hatchway and cover must be absolutely water-tight. Despite all precautions, some water finds its way in after one has been running a few hours submerged, but usually in such small quantities as to cause little inconvenience. On one occasion



THE "ISAAC PERAL" RUNNING ON THE SURFACE OFF THE SPANISH COAST.

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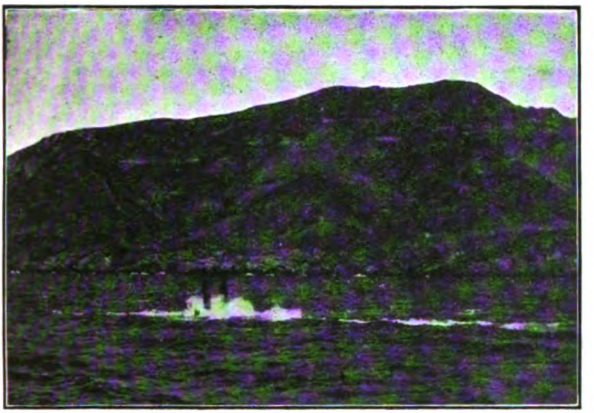
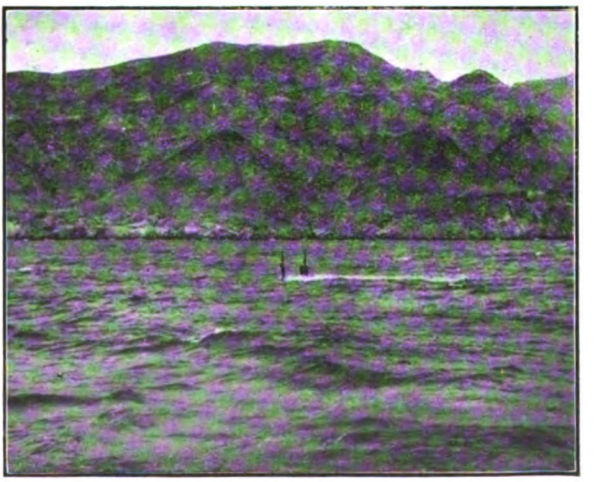


THE "ISAAC PERAL" RUNNING AWASH.

I noticed that water was slowly trickling down on to the aerial tuning inductance and finding its way thence to the transmitting condenser. After discovering what had been going on, I ceased to be surprised at the profuse sparking which occurred when I first started the set. A very merry little picnic party was held one day, when the vessel remained under water for ten consecutive hours, eight of which were actually spent resting on the bottom of the sea at a depth of about 120 feet. The meal was cooked on an electric stove and ended up with hot coffee and a game of cards.

The clearness with which articles can be seen in the water even at some depth caused me considerable surprise. On one occasion I followed the evolutions of the *A*.3. in the escorting motor-launch; and, although the submarine was navigating directly under us at a depth of 30 feet, its fish-like form was plainly discernible. It is this permeability of water to light which accounts for the success of aeroplanes in locating submarine craft. My two illustrations, on page 552, one of a torpedo under water, and the other a view taken in the conning tower of the submarine whilst submerged at a depth of 15 feet, will illustrate my point. The torpedo picture speaks for itself, the other photograph demands some explanation. My plate was exposed for a period of eight seconds, yet the image is not blurred in the slightest degree, a fact which constitutes no small tribute to the steadiness with which the boat was making her way. I utilised no flashlight, relying upon the natural illumination obtained through the portholes of the conning tower, and the luminosity of the water at this depth is demonstrated by the excellent portrait of the second officer which was obtained under such circumstances.

Perhaps the following description of the Italian-made *A*.1., *A*.2. and *A*.3. may interest my readers, in view of the fact that they are the result of my personal observation during the period I served upon them. They were constructed at the F.I.A.T. yards in Spezzia, and do credit to the excellence of Italian workmanship. Their displacement submerged is approximately 200 tons and their two 600 h.p. Diesel engines drive them at a surface speed of 12 knots. Electric accumulators enable them to maintain a speed of 5 miles per hour under water. The conning tower projects to a height of 5 feet above the



IN THE ACT OF SUBMERGING.

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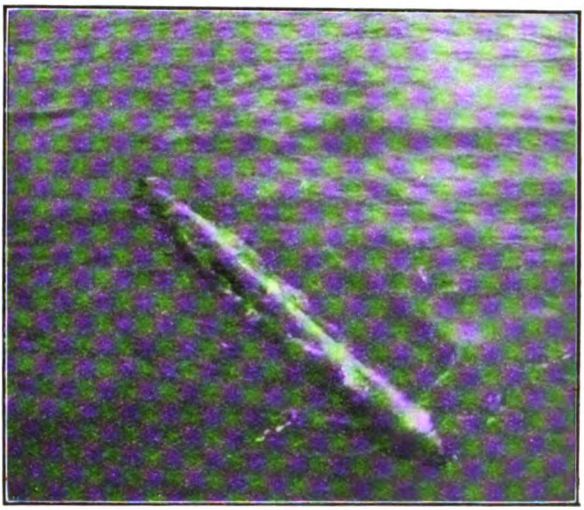

SPENT TORPEDO AS VIEWED FROM THE DECK OF THE SUBMARINE ESCORT.

deck and is furnished with five portholes through which the commander may reconnoitre the surrounding waters when travelling awash. Access is obtained by three hatchways, one at the bow, another at the stern and one on top of the conning tower; each hatchway being closed by means of a domed cover, hinged like a lid. Two long periscopes of a telescopic pattern pierce the conning tower and extend 15 feet above the deck. The roof answers the purpose of a navigating bridge when the vessel is travelling on the surface, being fitted with compass, steering wheel and other gear, all of which can be removed into the interior when submersion is imminent. Immediately underneath is located the operating or navigating room; here we find the various devices for working the vessel, including steering wheels, controlling both the ordinary rudder and the horizontal hydroplanes. These latter are fixed forward and astern of the submarine and serve the same purpose as those fitted on flying machines. The moving finger of a pressure gauge indicates the angle at which the vessel is travelling during ascent or descent, whilst other apparatus shows whether the craft is maintaining an even keel when running submerged. At such times the motive power utilised is generated by two large electric motors fed from an accumulator battery placed beneath the floor of the vessel. Special exhaust valves have been installed to expel the noxious gases formed during the charging of the accumulator battery.

Surface-vessel steering is carried out by the needle compass; but in a boat beneath the sea the influence of terrestrial magnetism is not felt, and the ordinary compass therefore becomes useless. This difficulty is overcome by the use of the gyro-compass, an elaborate electrical instrument, the main feature of which consists of a gyro-wheel, whereof the axle is adjusted so as always to remain parallel to the earth's axis in space. The frame of the gyro is fixed to the ship and moves with it. The underlying principle of the instrument rests upon the assumption that the rotation of the earth is changeless and undeviating, and that a large rotating wheel resists any tendency to being shifted relative to space. This gyro wheel is mounted upon ball bearings so exquisitely adjusted that when the electrical current which drives it has been

INSIDE THE CONNING TOWER AT THE DEPTH OF 15 FEET UNDERWATER.

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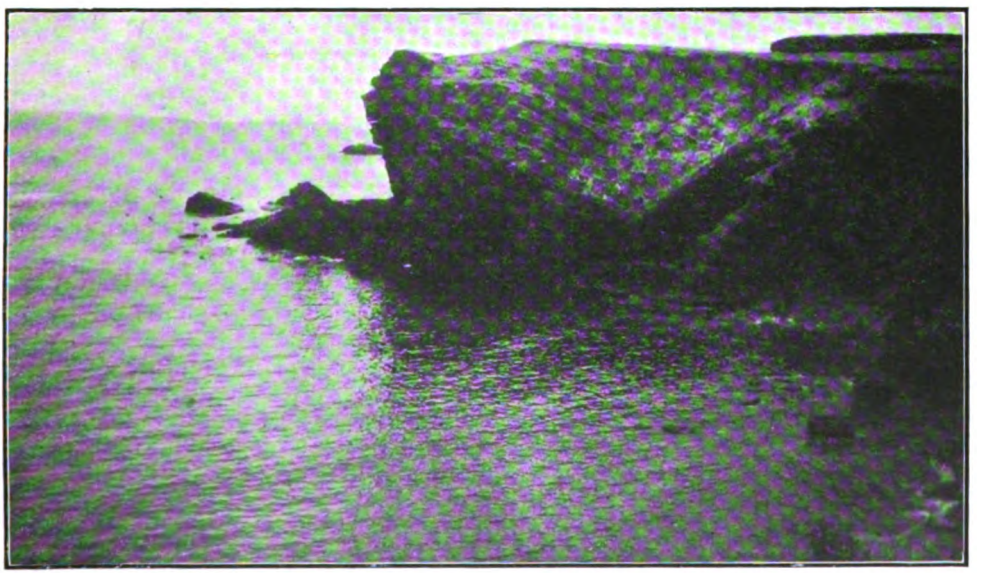
THE ESCORT.

switched off from the motor, the spin of the wheel does not cease for 14–16 hours. The complicated nature of this piece of mechanism may be gauged by the fact that it costs £2,000 to produce each instrument.

Signalling between two submarines or between a submarine and a battleship, when the former is under water, is carried on by means of sound waves. The Fessenden oscillator, used in the case of the Spanish submarines, consists of two large circular plates riveted to the hull of the ship on the port and starboard sides of the bow. These plates are set into vibration by electric currents controlled from a switchboard inside the boat. Two plates are used so that when they act as receivers, the telephones can be switched on to one or the other side, thus giving the direction from which the sound proceeds. The splashing of the oars of a small rowing boat can be distinctly heard when the boat is resting even at a depth of many feet. This signalling appliance possesses a normal range of approximately eighteen miles.

(To be continued.)



CAPE PALOS, NEAR CARTHAGENA. THE LOCALE OF A MARCONI WIRELESS STATION WELL KNOWN TO MARINERS.

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The Vision of a Scientist

Some Remarkable Forecasts of Sir William Crookes

On the advent of Senatore Marconi's wireless telegraph innumerable claims to priority were put forward by scientists and others who endeavoured to prove that they themselves had undoubtedly thought of the same thing years before. One by one these claims were proved to be false, until now the originality of the famous Italian inventor's work is universally recognised. The success of Senatore Marconi's early work was largely based upon his clarity of vision and his ability to recognise the possibilities that lay in the utilisation of etheric waves. Obviously the raw material for the invention was found in the pioneer work of Hertz and others, but it was his clear understanding of what Hertz had done that provided the driving force to overcome innumerable difficulties.

There was, however, another scientist whose vision was marked by the same clarity. That man was William Crookes, F.R.S., later to be honoured with a knighthood. The scientific achievements of this great man are briefly recorded on another page. Here it is our purpose to reproduce a portion of a paper contributed by him to the *Fortnightly Review* for February, 1892—four years before Marconi took out his first British patent and five years after Hertz announced his famous discoveries. It is also of interest to note that it was in this year that Edouard Branly invented the first crude coherer.

We wish to lay emphasis upon the fact that this paper, which is without question the most remarkable and detailed prophecy of wireless telegraphy ever promulgated, antedated practical radiotelegraphy by no less than four years. It is only by bearing this fact in mind that readers will appreciate Sir William Crookes's remarkable prophetic vision. The paper was entitled "Some Possibilities of Electricity," and as it has been virtually inaccessible to the public for many years, we reprint herewith the whole of that portion which has a bearing on wireless telegraphy.

"We know little as yet," said the writer, "concerning the mighty agency we "call electricity. 'Substantialists' tell us it is a kind of matter. Others view it, "not as a matter, but as a form of energy. Others, again, reject both these views. "Professor Lodge considers it 'a form, or rather a mode of manifestation of the "'ether.' Professor Nikola Tesla demurs to the view of Professor Lodge, but thinks "that 'nothing would seem to stand in the way of calling electricity ether associated "'with matter, or bound ether.' High authorities cannot yet even agree whether "we have one electricity or two opposite electricities. The only way to tackle the "difficulty is to persevere in experiment and observation. If we never learn what "electricity is; if, like life or like matter, it should always remain an unknown "quantity, we shall assuredly discover more about its attributes and functions.

"The light which the study of electricity throws upon a variety of chemical "phenomena—witnessed alike in our little laboratories and in the vast laboratories "of the earth and sun—cannot be overlooked. Without going into transcendental "speculations as to the origin of all things, it may be mentioned that the theory "which now meets with most favour as best representing the genesis of the chemical "elements is, that at the time each element was differentiated from the all-pervading "*protyle*, it took to itself definite quantities of electricity and upon these quantities "the atomicity of the element depends. Professor Oliver Lodge expresses this "when he says, 'Every monad atom has associated with it a certain definite quantity "'of electricity; every dyad has twice this quantity associated with it, every triad "'three times as much, and so on.'* Helmholtz considers it to be probable that

* *On Electrolysis*, British Association Reports, 1885.

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" electricity is as atomic as matter and that an electrical atom is as definite a quantity " as a chemical atom. This, however, must not yet be regarded as a certainty, for " it is possible that all the facts at present known may be explicable in another way. " If an atom of matter is endowed with the property of taking to itself one, two, " three, or more units of electricity, it does not follow that electricity is atomic. " Imagine the atoms of matter to act like so many bottles, capable of holding one, " two, three, or more pints. Imagine electricity to be like water in the ocean, " which for the purposes of this argument may be considered inexhaustible and " structureless. One of the atomic ' bottle ' elements dipped into the ocean would " certainly take to itself, one, two, three or more pints of water, but it would by " no means follow that the ocean was atomic in that it was capable of being divided " up into an infinite number of little parcels, each holding a pint or its multiple.

" For this and other reasons I think we must accept the hypothesis of the atomic " character of electricity as not yet definitely proved, although it is not improbable.

" I have spoken of the ' ether '—an impalpable, invisible entity, by which all " space is supposed to be filled. By means of the ether theory we can explain " electrical phenomena, as well as those appertaining to the phenomena of light.

" Until quite recently we have been acquainted with only a very narrow range " of ethereal vibrations, from the extreme red of the solar spectrum on the one side " to the ultra-violet on the other—say, from three ten-millionths of a millimetre " to eight ten-millionths of a millimetre. Within this comparatively limited range " of ethereal vibrations and the equally narrow range of sound-vibrations all our " knowledge has been hitherto confined.

" Whether vibrations of the ether, longer than those which affect us as light, " may not be constantly at work around us, we have until lately never seriously " enquired. But the researches of Lodge in England, and of Hertz in Germany, " give us an almost infinite range of ethereal vibrations or electrical rays, from " wavelengths of thousands of miles down to a few feet. Here is unfolded to us a " new and astonishing world—one which it is hard to conceive should contain no " possibilities of transmitting and receiving intelligence.

" Rays of light will not pierce through a wall, nor, as we know only too well, " through a London fog But the electrical vibrations of a yard or more in wave- " length of which I have spoken will easily pierce such mediums, which to them will " be transparent. Here, then, is revealed the bewildering possibility of telegraphy " without wires, posts, cables, or any of our present costly appliances. Granted a " few reasonable postulates, the whole thing comes well within the realms of possible " fulfilment. At the present time experimentalists are able to generate electrical " waves of any desired wavelength from a few feet upwards, and to keep up a " succession of such waves radiating into space in all directions. It is possible, too, " with some of these rays, if not with all, to refract them through suitably shaped " bodies acting as lenses, and so direct a sheaf of rays in any given direction; " enormous lens-shaped masses of pitch and similar bodies have been used for this " purpose. Also an experimentalist at a distance can receive some, if not all, of " these rays on a properly constituted instrument, and by concerted signals messages " in the Morse code can thus pass from one operator to another. What, therefore, " remains to be discovered is—firstly, simpler and more certain means of generating " electrical rays of any desired wavelength, from the shortest, say, of a few feet in " length, which will easily pass through buildings and fogs, to those long waves " whose lengths are measured by tens, hundreds, and thousands of miles; secondly, " more delicate receivers which will respond to wavelengths between certain defined " limits, and be silent to all others; thirdly, means of darting the sheaf of rays in " any desired direction, whether by lenses or reflectors, by the help of which the " sensitiveness of the receiver (apparently the most difficult of the problems to be " solved) would not need to be so delicate as when the rays to be picked up are

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" simply radiating into space in all directions, and fading away according to the " law of inverse squares.

" Any two friends living within the radius of sensibility of their receiving instru- " ments, having first decided on their special wavelength, and attuned their respective " instruments to mutual receptivity, could thus communicate as long and as often " as they pleased by timing the impulses to produce long and short intervals on the " ordinary Morse code. At first sight an objection to this plan would be its want " of secrecy. Assuming that the correspondents were a mile apart, the transmitter " would send out the waves in all directions, filling a sphere a mile in radius, and it " would therefore be possible for any one living within a mile of the sender to receive " the communication. This could be got over in two ways. If the exact position " of both sending and receiving instruments were accurately known, the rays could " be concentrated with more or less exactness on the receiver. If, however, the " sender and receiver were moving about, so that the lens device could not be adopted, " the correspondents must attune their instruments to a definite wavelength, say, " for example, fifty yards. I assume here that the progress of discovery would give " instruments capable of adjustment by turning a screw or altering the length of " a wire, so as to become receptive of wavelengths of any preconcerted length. Thus, " when adjusted to fifty yards, the transmitter might emit, and the receiver respond " to, rays varying between forty-five and fifty-five yards, and be silent to all others. " Considering that there would be the whole range of waves to choose from, varying " from a few feet to several thousand miles, there would be sufficient secrecy; for " curiosity the most inveterate would surely recoil from the task of passing in review " all the millions of possible wavelengths on the remote chance of ultimately hitting " on the particular wavelength employed by his friends whose correspondence he " wished to tap. By ' coding ' the message even this remote chance of surreptitious " straying could be obviated.

" This is no mere dream of a visionary philosopher. All the requisites needed " to bring it within the grasp of daily life are well within the possibilities of discovery, " and are so reasonable and so clearly in the path of researches which are now being " actively prosecuted in every capital of Europe that we may any day expect to " hear that they have emerged from the realms of speculation into those of sober " fact. Even now, indeed, telegraphing without wires is possible within a restricted " radius of a few hundred yards, and some years ago I assisted at experiments where " messages were transmitted from one part of a house to another without an inter- " vening wire by almost the identical means here described.

" The discovery of a receiver sensitive to one set of wavelengths and silent to " others is even now partially accomplished. The human eye is an instance supplied " by Nature of one which responds to the narrow range of electro-magnetic impulses " between the three ten-millionths of a millimetre and the eight ten-millionths of a " millimetre. It is not improbable that other sentient beings have organs of sense " which do not respond to some or any of the rays to which our eyes are sensitive, " but are able to appreciate other vibrations to which we are blind. Such beings " would practically be living in a different world to our own. Imagine, for instance, " what idea we should form of surrounding objects were we endowed with eyes not " sensitive to the ordinary rays of light but sensitive to the vibrations concerned in " electric and magnetic phenomena. Glass and crystal would be among the most " opaque of bodies. Metals would be more or less transparent, and a telegraph wire " through the air would look like a long narrow hole drilled through an impervious " solid body. A dynamo in active work would resemble a conflagration, whilst a " permanent magnet would realise the dream of mediæval mystics and become an " everlasting lamp with no expenditure of energy or consumption of fuel.

" In some parts of the human brain may lurk an organ capable of transmitting " and receiving other electrical rays of wavelengths hitherto undetected by instru- " mental means. These may be instrumental in transmitting thought from one

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" brain to another. In such a way the recognised cases of thought transference, " and the many instances of ' coincidence,' would be explicable. I will not speculate " on the result were we eventually to catch and harness these ' brain-waves.'

" Whatever be the length of the electric wave, the velocity with which it travels " is constant, and is equal to the velocity of light, or about one hundred and eighty " thousand miles a second. Professor Oliver Lodge, who has worked for some years " on these subjects, gives formulæ * for calculating the frequency of vibration and " the wavelength of the electrical rays given by the discharge of Leyden jars of " different capacities. The bigger the jar and the greater the size of the circuit " the longer will be the waves. Thus a pint jar discharging through a two-yard " circuit will give waves of a length of fifteen or twenty metres, and they will follow " each other at the rate of ten million a second. A jar the size of a thimble will " give waves only about two or three feet long, and they will succeed one another " at the rate of two hundred and fifty or three hundred millions a second. With " every diminution in size of the apparatus the wavelengths get shorter, and could " we construct Leyden jars of molecular dimensions, Professor Lodge considers the " rays might fall within the narrow limits of visibility. We do not know the intimate " structure of a molecule sufficiently to understand how it could act as a Leyden " jar ; yet it is not improbable that the discontinuous phosphorescent light emitted " from certain of the rare earths when excited by a high-tension current of electricity " in a good vacuum is really an artificial production of these electric waves, suffi- " ciently short to affect our organs of vision. If such a light could be produced " more easily and more regularly it would be far more economical than light from " a flame, or from the arc or incandescent lamp, as very little of the energy is " expended in the form of heat rays. Of such production of light Nature supplies " us with examples in the glow-worm and the fire-flies, whose light, though suffi- " ciently energetic to be seen at a considerable distance, is accompanied by no " liberation of heat capable of detection by our most delicate instruments."

Correspondence

To the Editor, THE WIRELESS WORLD.

DEAR SIR,—My attention was directed to a book by Charles Bright, *Telegraphy, Aeronautics and War,* on the ground that there were several references in it to code matters, and I therefore procured a copy, eagerly hoping that a new luminary had appeared in the firmament of code experts, but my expectations were speedily shattered, and instead of a brilliant star I found a body of very low magnitude indeed.

The tenor of the whole work is that while wireless under certain favourable circumstances may be usefully employed as an auxiliary to cables, it was worthless, in fact dangerous, to use it for sending business messages in code, or for use in time of war. In the able review of *Telegraphy, Aeronautics and War* which appeared in your December number, it was pointed out that many of Mr. Bright's conclusions were based upon erroneous assumptions—in fact, for a Fellow of the Institute of Radio Engineers he would appear to be surprisingly ignorant of some quite elementary features of wireless telegraphy. When he touches upon code matters his ignorance is positively abysmal.

On page 52 the author asserts that " the present war soon gave proof that it " would never do to rely upon ' wireless ' as a secret method of communication," and farther on he points out that there can be no certainty of the origin of wireless messages. Is the writer endeavouring to impugn the marvellous work done by the Signal Division of the Admiralty ? They have provided perfect systems of coding

* *Modern Views of Electricity*, pp. 246-7.

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and call signals, which have been used regularly during the war, nearly half a million wireless messages being exchanged every week, without any question whatever as to their authenticity or the enemy benefiting from them. Many naval officers have stated that there can be no doubt whatever that had the invention and development of the submarine preceded that of wireless telegraphy this country would have been defeated, and when one considers how the efforts of the huge fleet of motor boats, scouts, trawlers, destroyers and other craft detailed to counter the barbarous campaign of piracy, were co-ordinated and controlled by "wireless", messages *in code*, even the most jaundiced or biased opponents of radiotelegraphy must admit that Mr. Bright's contentions are absolutely fallacious. Curiously enough, however, when it suits his case the author changes his tone, as in a later chapter he recommends the State administration of wireless for "secrecy reasons." If, as he iterates and reiterates, there can be no real secrecy in wireless messages, this is a peculiar argument, to say the least of it.

Turning to the commercial use of wireless, the author appears to think that messages in code cannot be accurately transmitted. He seems to be oblivious to the fact that up to the time when the Government took over the Marconi high power stations for war purposes a large volume of transatlantic business was being handled, and the banks and leading commercial men of the City are eagerly awaiting the re-opening of this service. With regard to accuracy, not only does the ever-increasing demand prove that the Marconi system has been satisfactory in every way, but all the cable men who have accepted posts in Marconi's Wireless Telegraph Company are amazed at the exceedingly small number of errors in transmission of coded messages.

Mr. Bright repeatedly states that codes or cipher codes are of no value, and on page 158 he says, "It is well known that, provided a sufficient number of words are passing, any cipher yet invented can be deciphered." Now this is a broad, comprehensive and sweeping assertion. The author does not employ any qualification such as "as far as *I* know." There is a finality about the statement that arouses my curiosity, and I should like to challenge Mr. Bright to arrange, either through the intermediary of THE WIRELESS WORLD, or in some other way, to test the accuracy of his statement impartially, and under much more favourable conditions than he can have had in his mind when he so calmly laid down the law.

(Signed) J. C. H. MACBETH.

The Editor, THE WIRELESS WORLD.

DEAR SIR,—On page 263 of the August issue is an article headed "A Radio Phenomenon" dealing with the effects of smoke passing through an aerial.

In both the cases mentioned the effects noticed were produced by smoke from passing trains. This "smoke" was probably composed largely of steam from the engine exhaust, and I venture to suggest that the observed effects were due to steam rather than to smoke. On several occasions whilst perusing works on electricity I have seen it stated that a jet of high-pressure steam, issuing from a boiler, produces such an effect that a severe electric shock will be experienced on touching that part of the boiler from which the steam issues.

Reverting to the case in question I suggest that the exhaust steam from the engine produces an effect inside the engine similar to the above and carries off with it some of the electric charge. On being intercepted by a wireless aerial these steam clouds will naturally discharge to earth through it, producing an effect in the receiving instrument akin to static interference. It might be termed "home-made" static.

Trusting this will be of interest, and with best wishes,—Yours, etc.,

(Signed) A. DINSDALE.

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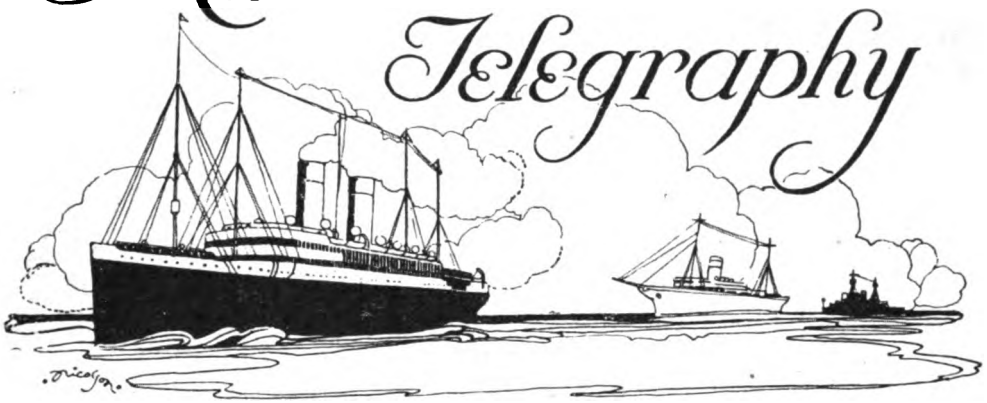
Maritime Wireless Telegraphy



History-Making by Wireless.

It was very justly observed by one of our weekly contemporaries that radio-telegraphy has provided a new mode of opening up negotiations between opposing armies, unknown to our forefathers. Without wireless, in the conditions obtaining on the Western Front, it is very difficult to say how the Parlementaires could have advanced without considerable danger to themselves. Considerable delay must, at all events, have arisen when they desired to consult their own Headquarters concerning the terms of the victors. Indeed the services which wireless has performed all through the period of armistice have continued to be notable in this respect. Communications have gone on all day and every day between the opposing forces, and the solemn (though belated) protests of both the British and French Governments against the scandalous treatment of prisoners of war belonging to their respective nationalities have been carried by the same medium.

At sea, the difference between the procedure of the present time and former days has been to the full as marked. Instead of sending light frigates under a flag of truce, the ether waves enabled Admiral Meurer to make an appointment for rendezvousing at sea, and then to proceed straight to the appointed meeting place. We have by this time become so familiar with the smooth working of radio-telegraphic conversation that scarcely any feeling of wonderment appears to have been stirred amongst Press or public by the clockwork regularity of the whole set of complicated operations. That matters have worked with so few hitches is due to wireless alone. Surely here there is some room for congratulation, if not for wonderment. Never before has the history of naval war witnessed the abject surrender of a fleet in complete order, unscathed by warlike operations. And equally it is without precedent that, in the course of carrying out such operations as have been dictated by the conqueror, a beaten foe has been able to receive instant admonition for shortcomings and afforded opportunities for explaining his difficulties and for putting matters straight without the slightest delay. Occasions have occurred when armistices have broken down and hostilities been renewed, simply owing to misunderstandings brought about by lack of communication between the parties concerned.

One of the batch of twenty submarines, which were due on a certain day towards the close of November, did not turn up, and immediately the British Admiral fired off the following message from his aerials :—

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"Request you will report on the sinking of U93, as the same appears to have been avoidable."

A full apology and explanation of the incident was returned by wireless from the German authorities, and arrangements were made for the prompt surrender of another vessel in place of that which had failed to turn up.

Again, the British found some of the gear which ought to have accompanied the surrendered vessels was missing on their arrival. A complaint was forthwith radiated in the following terms :—

"Torpedoes you failed to send with the latest convoy of submarines you will forward by next transport."

Once more the erstwhile Bully, but now obsequious under-dog, hastened to put the matter straight.

The change from truculence to oily deference, which was plainly marked in the attitude of the Teutonic seamen, appears to have put the finishing touch upon the contempt felt by our glorious sea dogs. They could waste small respect on men who had proved themselves so bold in shelling defenceless towns and torpedoing hospital ships, and then become so supremely anxious to save their own skins when it came to a question of fighting man to man and ship to ship.

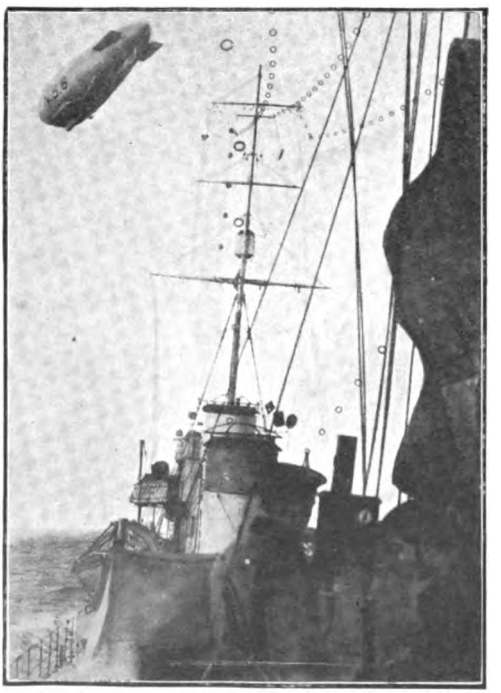
We do not know whether the Germans attempted to utilise the ether waves for toadying palaver. We do know that they had been rapped on the knuckles for such attempts when their delegates first visited the quarter deck of our admiral's ship. It may have been due to such a cause, or it may have simply been due to the same contemptuous spirit of taking no risks when dealing with a treacherous foe, that a wireless message went out from the British Commander ordering that :—

"You will stop using your wireless until further orders."

Assuredly Sir David Beatty is disappointed at having been baulked of the prey whose arrival he had been awaiting with such eagerness for four long years.

It is reported that not long before Armistice Day he called his men together on board "Big Lizzie." "Men," said he in his abrupt incisive manner, which gives the impression that he is biting his words as they issue from his mouth, "they're coming "out. I always said they would." On the day of the Great Surrender he once more addressed them. "Men, I "always told you they'd come out . . . "not on a piece of string though."

This feeling of disgust is plainly to be seen written between the words of his wireless messages. Surely as without precedent as any other item in this extraordinary naval *débâcle*, is the way in which, through the ether waves, the British Admiral has been making the Huns "eat dirt."



[*Graphic Photo Union*

THE WIRELESS AERIALS OF A BRITISH MAN-OF-WAR WITH THE NAVAL AIRSHIP WHICH ESCORTED THE GERMANS TO THEIR SURRENDER.

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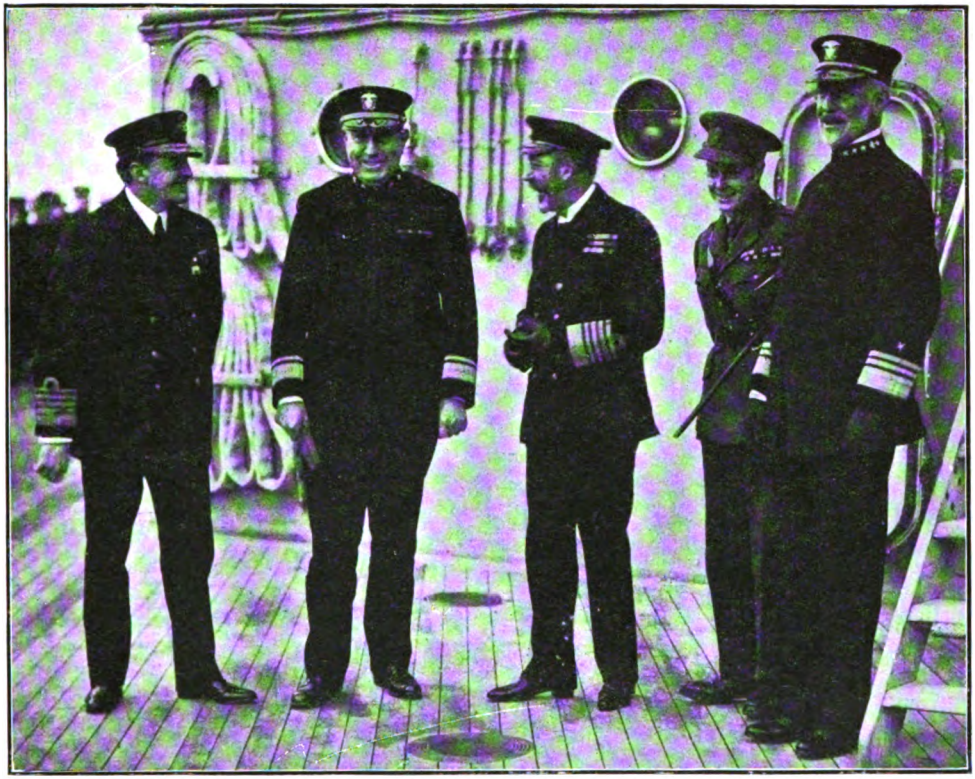

[*Graphic Photo Union.*

A NOTABLE GROUP ON THE VICTOR'S QUARTER DECK. READING FROM LEFT TO RIGHT: ADMIRAL BEATTY, ADMIRAL RODMAN, U.S.N., HIS MAJESTY, THE PRINCE OF WALES, AND ADMIRAL SIMS, THE COMMANDER OF THE U.S. NAVAL FORCES.

A Novel Incident in the War at Sea.

We notice in the pages of one of our contemporaries a reference to an incident which occurred early in 1917 in the Mediterranean, not far from the island of Crete. The s.s. *Huntsend* was torpedoed by one of the pests who at that time infested the waters of the Great Sea, and, in accordance with the custom, sent out an appeal by wireless for help. An escorting destroyer took off everyone on board and steamed away, leaving the vessel derelict. Meantime another destroyer, some distance away, had picked up the wireless message, and hurried to the spot. A visit to the unfortunate vessel soon disclosed the fact that there was nobody left on board; so the gallant bluejackets boarded the ship and, after strenuous efforts, succeeded in fetching her sufficiently near the shore to be beached for repairs. These were executed, and in the course of time the salvaged vessel reached England. Wireless telegraphy had been responsible for initiating a dual task. Through its agency rescuers had been summoned to save lives; and through its agency one more sorely needed vessel had been preserved for "carrying on" our overseas trade.

One would have thought that under the regular maritime rules the men who preserved the vessel from destruction would have received salvage money. According to our contemporary, however, that is not the case up to the present, and, assuming the fact to be as stated, an injustice would appear to have been done them in this respect.

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The Armistice

How Marshal Foch's Wireless Message was Received in London

In the very early days of the war wireless operators who happened to have their instruments tuned to a certain wavelength frequently heard, during both day and night, the following message transmitted by a well-known German station: "Krieg ist erklärt gegen England, Frankreich und Russland" ("*War is declared against England, France and Russia*"). The note of the signals was shrill and defiant; the message, considering all that lay behind, was a veritable challenge to the world. Whilst Brialmont's masterpieces at Liége were falling into unconsidered heaps of concrete and steel beneath the blows of Krupp's 8·4 inch howitzers and the invading flood of "field-greys" was smothering everything Belgian, this message continued to be flung out with monotonous insistence. The impression received by those who heard it so often was that Germany considered England, France and Russia to amount to about a bite and a half and that they were trying to make our flesh creep, like the Fat Boy in the *Pickwick Papers*.

Some four years later the final answer to this war-cry was sent out, appropriately enough, by a French wireless station in Paris—that pot of gold on the end of the rainbow, which dazzled the wits and escaped the paw of the Blonde Beast. As everyone knows, in the forenoon of Friday, November 8th, the German delegates were informed of the terms upon which the Allies and the United States were willing to grant an armistice; those terms had to be accepted or rejected within 72 hours, that is, by 11 a.m. on November 11th. What need is there to describe the state of expectancy into which the world was thrown at this stage? It seemed too good that the terms should be accepted; yet incredible that they should be refused. This mixed sense of excitement, hope and curiosity was specially intense in the minds of a few men in the Admiralty wireless station at Marconi House who had been detailed to maintain a special watch upon all wireless activity in connection with the armistice proceedings. Marshal Foch and the delegates used the Eiffel Tower station in order to communicate with the German High Command at Spa, at which place there was another wireless station, so that the watch became easily resolved into an observation of the messages transmitted by these stations, particularly those from Eiffel Tower.

Would they sign? Would they sign early? Or would they hang on to the last minute? These were the burning questions which besieged the minds of those who sat by day and by night in that small room below the aerials of Marconi House. Eiffel Tower was by no means silent during those hours in which the German delegates stared into the face of Nemesis and saw that it was graven steel. There was the first whining cry from Erzberger to his masters when he realised that his council-table craft would not be needed. Foch's "Take them or leave them!" had from the outset abolished bargaining. Then came another cry, that Foch would not until the terms were accepted—not even for humanity's sake—call off his dogs of war from Mons, Mézières and Sedan.

Again the Eiffel Tower spoke to Spa. "Two naval cipherers" were desired

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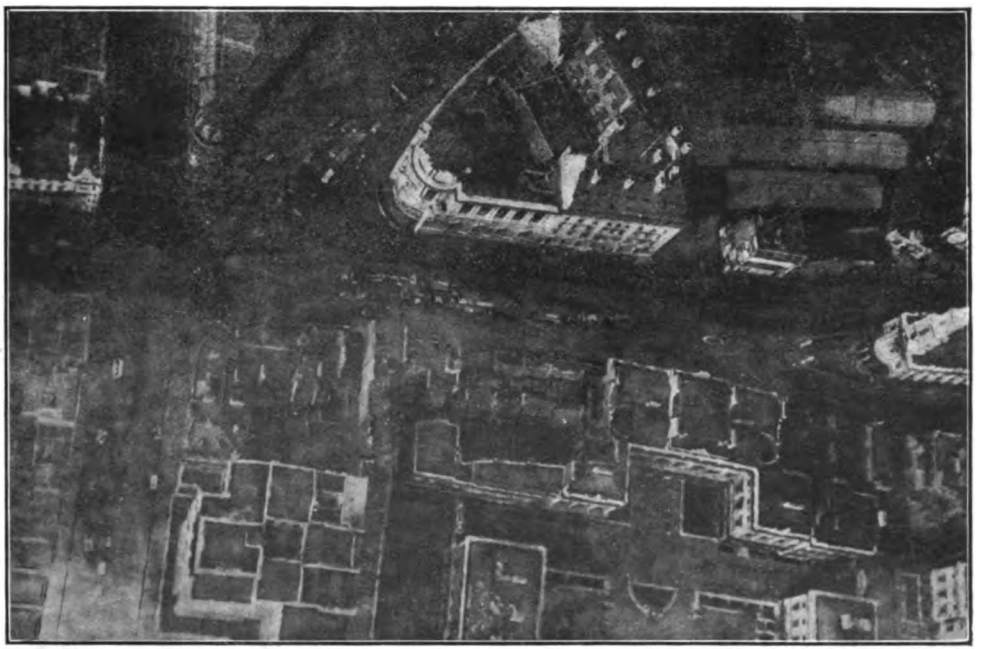
by the delegation to proceed from Germany to the Marshal's headquarters. (" *Ah,*" *said the watchers to each other,* " *that is Wemyss at work.*") Time wore on ; Friday and Saturday passed but still IT did not come, and the watch continued. To the men engaged it all became a great drama witnessed by wireless. One could piece it together by the aid of the messages and envisage the scene, the voluble, gloomy Teutons, the grizzled, politely firm Foch and the immaculately groomed British admiral, model of cool efficiency. One wanted to be " in at the death," and it was with reluctance that the telephone receivers were handed over to the relief.

Sunday passed and it was felt that things were about to happen. Every time the note of the Eiffel Tower station was heard and the operator's pencil began to move a thrill passed over the little waiting company. Have they done it ? Is



The Central News, Ltd.

AN AIRSHIP VIEW OF THE STRAND, KINGSWAY AND MARCONI HOUSE. THE AERIALS ON WHICH THE ARMISTICE MESSAGE WAS RECEIVED ARE STRETCHED ABOVE THE BUILDING.

the war over ? Nothing ! Only a courier was held up by broken bridges and gunfire. (" *Still couriers ? Why don't they sign ?* ")

The early hours of Monday, November 11th, and only about nine hours remaining in which to save the German army from the tender mercies of the " contemptibles," the degenerate *poilus* and " those idiotic Yankees " ; a few more hours of killing, a few more hours till dawn. In that quiet upper room overlooking the Strand the excitement of the preceding days had given place to a nervous intentness. Never did men await a more tremendous moment or wireless operators a more historic message, and yet London slept,—that London which before lunch-time was to become as light-hearted and irresponsible as a continental city at carnival ; London slept, save in those busy places where night workers still fashioned the engines and munitions of war. A strange contrast ! To one man it was given to make the shell or sharpen the bayonet ; to another that he should keep his ear as it were at the door of the chamber whence Peace might issue.

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And then, as light came, as the dawn came to sad south-western Europe, illumining its desolation and the little crosses on its myriad graves, another message also came; it was the answer to that German mandate of August, 1914, that war should be.

"*Marshal Foch to Commanders-in-Chief: Hostilities will cease on the whole front on November 11th, at 11 a.m. The Allied troops will not, until further orders, pass beyond the line reached at this date and time. Signed: Marshal Foch.*"

This message was written by a Frenchman and transmitted by wireless in French and English to the listening world. What it said was that hostilities should cease; what it meant was that Germany, having staked everything, had lost all save her shame and blood-guiltiness. It was noted that the formation of the Morse characters as sent from the Eiffel Tower station was occasionally tremulous or erratic. Small wonder that this was so! There was a man whose heart beat swifter for *la patrie* in that hour. After the manner of his kind the Englishman who wrote down the message here in London grumbled about his pencil and smoked hard to hide his feelings.

The news was hurried off to the authorities—a small boy on a bicycle bore it. There is something of humour in that fact when you consider that the British Empire was waiting for him.

* * * * * *

From the windows of the wireless room the watchers looked out on London a few hours later to observe the results of their labours. At nine o'clock it amounted to little more than rumour; the early milkman had it and a man in a Department which "controlled" something had heard it over the telephone. In large offices the mails remained unopened and young ladies were slow to uncover their typewriters. By ten o'clock it really began to be a fact and one could see the truth *leaking out*. Girl clerks at Somerset House lined the windows or dashed hatless into the Strand; it is reported that even their lady supervisors thawed after a short preliminary frost and became quite malleable. Presently newspapers appeared, early even as "noon editions," and the glorious, amazing news at last reached the mind of the public. It reached people's hearts too. And then the covers of the typewriters were snatched and became drums of victory, office towels and dusters flew as flags, the Strand received as a torrent the staffs of its offices. Excited groups in the street waved and cheered to people on the tops of passing 'buses, who first stared, then understood and became galvanised. Suddenly came a sound which the Strand had heard before, and the crowds were hushed for a moment. It was the dull report of the maroons. Eleven o'clock had struck and the Great War was over. So, then, there was nothing for wireless operators to do—but to go on watching.

It is interesting to compare the manner in which Marshal Foch's message was conveyed to England with that in which the news of the victory of Waterloo was brought. In the latter case, picture the despatch-rider in his gallop to the coast, the slow hazardous passage across the Channel in some cockle-shell packet-boat, the furious dash to London, with trails of cheering villagers and scared poultry, the awakening of a Minister of State—you can see him gradually gathering his Georgian dignity in spite of his nightcap—and finally the audience of the King. The other picture shows us the dapper soldier writing on a telegraph form, a military telegraphist saluting and sitting down to manipulate a knob for two minutes, the wireless station, the movement of machines, the intermittent glare of a spark and the quiet routine of reception and despatch in that small room in Marconi House. Less than an hour after Germany had acknowledged in writing her defeat the news was in London and on its way to the Press via the Censor, the intelligence having arrived at the speed of 186,000 miles a second.

They say that ours is not an age of romance, but romance is only wonder and never dies, although its nature changes with the changing years.

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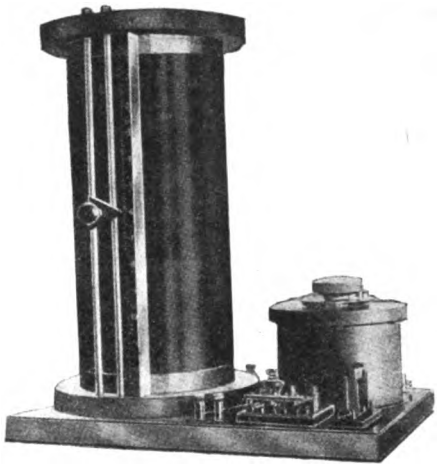
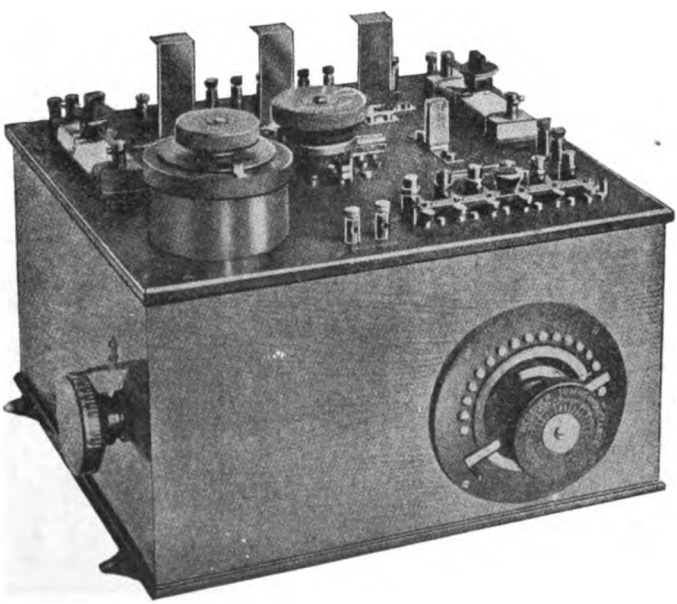
Long-Distance Wireless

THE recent announcement of direct wireless communication between England and Australia and the reception of the signals in Australia upon newly designed apparatus has brought us many queries from readers as to what type of receiver was used. We are therefore pleased to be able to reproduce here two photographs, one showing the aerial tuning inductance and condenser and the other the valve receiver used in connection therewith. The receiver, which utilises three small Marconi Q-type valves, was constructed entirely in Australia by Mr. E. T. Fisk, managing director of Amalgamated Wireless (Australasia), Ltd., and his staff, and, as will be seen, has a very compact appearance.



AERIAL TUNING UNIT.

We are not yet in a position to give the practical outlines of the circuits used, but hope in the near future to give our readers a complete diagram of connections. The success of this reception over a distance of 12,000 miles is even more remarkable when it is considered that the signals were received on a very small aerial at Mr. Fisk's own private house. Signals were also received on the same apparatus not only from Carnarvon but from a number of other European stations almost equally distant, the strength of reception on many occasions being sufficient to enable the signals to be read several feet away from the telephone receivers laid upon the table. It has been stated that the war has brought forward the science of aviation to a position which it would not have otherwise occupied for some forty or fifty years, and while the same can scarcely be said about wireless telegraphy it is an undoubted fact that the wide application and extensive study of this subject brought about by war conditions have made possible many of the recent advances from which the veil is only just being lifted. We are looking forward with interest to the possibilities opened out by the fitting of modern and highly sensitive receivers to ships at sea when these vessels resume the normal commercial working, and we have no doubt that in the near future the power used will be found to be not below but in excess of requirements. On this subject we shall have more to say in an early issue.



VALVE AND SECONDARY TUNING UNIT.

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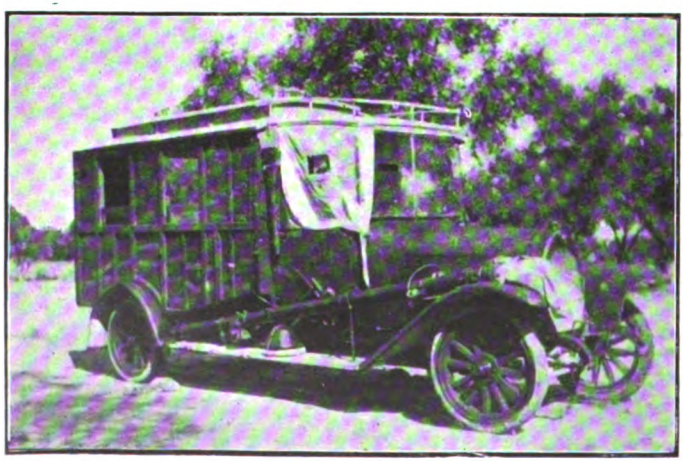
Notes of the Month

Freedom.

Liberty is in a bad way. The ex-Kaiser and his satellites deliberately organised a *régime* of a highly centralised nature, in which repression of liberty was carried to its furthest extreme. This course was deliberately adopted by them in order to contribute to the efficiency of their war machine. The Allied Powers, loudly proclaiming that Freedom was the basic principle for which they stood, found themselves handicapped for the struggle by the liberty which their individual citizens enjoyed. Their first concerted action was, therefore, to abolish all personal freedom of action, with the result that the sacred cause had to be upheld by a violation of its first principle! As the war progressed, the stringency wherewith the suppression of deed, word, and even thought was carried increased ever more and more, until we found ourselves unable to have a voice in what we should eat, what we should drink, or wherewithal we should be clothed. We were told, and tried hard to believe, that all this would be merely temporary; but is it?

Many of us notice with considerable misgiving that it appears very much easier to surrender liberty than to regain it. Mr. Lloyd George, when replying to some deputies from a teetotal organisation, who urged still further "control," answered that "we should certainly not fail to profit by the lessons of the war"! The United States of America, which owe so much of their radiotelegraphic progress to the freedom from restraint enjoyed in the past by their wireless experimentalists and wireless workers in general, instituted the most rigorous repression for the purposes of the war; and now that peace has come we observe the foreshadowing of a purpose to keep this industry in leading strings under the guise of "Navy Control." An announcement was made towards the end of November last that

"Mr. Wilson has approved a scheme for the permanent control of all wireless communication by the American Navy. The plan, which is based upon purchase of plants, will be submitted to the next Session of Congress."



CAPTURED GERMAN WIRELESS. THE POWER UNIT AND MAST GEAR LORRY.

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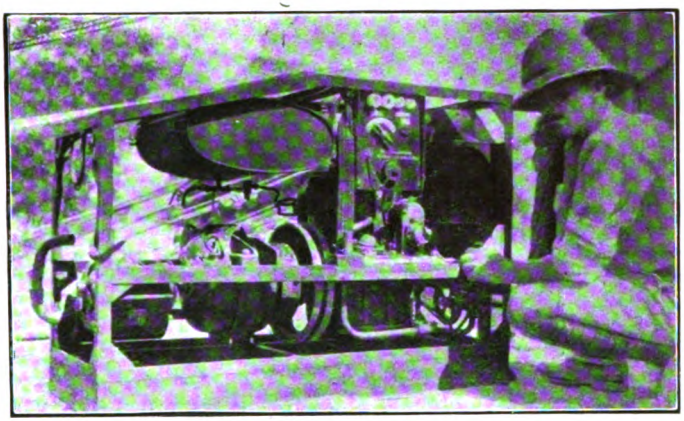
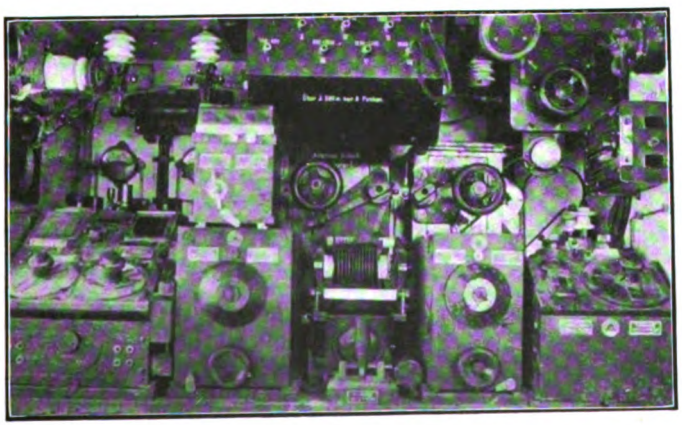


CAPTURED GERMAN WIRELESS.
THE POWER UNIT OF 1½ KW. SET.

Without any wish to prejudge the issue, which must largely depend upon the details of the measure, we should like to point out the danger which lurks under the apparently innocent cloak of State control of wireless. The industry is young, and, despite its already marvellous developments, there are still immense possibilities ahead of it, which demand for their realisation the utmost exercise of human ingenuity. It is notorious that State enterprise does not tend to foster progress. Indeed, the British Post Office, which is sometimes given as an instance of a successful State organisation, owes a very great proportion of its success to the pressure brought to bear upon it from outside. Government industrial enterprise cannot always rely upon the invigorating criticism and indomitable perseverance of men like Sir John Henniker Heaton.

WIRELESS AND THE PRESS.

One of the developments of this war which have come to stop is the intimate connection between wireless and the Press. The former commends itself as a method of communication specially suitable for newspaper work, and future developments in this direction are likely to be startling. In the interests of the public it is highly desirable that both should be freed from their present fetters at the earliest possible moment. It is hardly too much to say that the recent bloody struggle would have lasted only as many months as it did years, if the wireless services of the Central Empires had been free, and the Press at liberty to put their readers in possession of the facts. The Prussian Junker gang, however, controlled both means of communication and media of publicity, with the result that the German people are only now beginning to have some glimmerings of the truth. It may be said that such repressive manipulation is characteristic of autocracy, and that its antithesis will be free from the taint. Alas! experience tells a different tale, and



CAPTURED GERMAN WIRELESS.
GENERAL VIEW OF THE APPARATUS.

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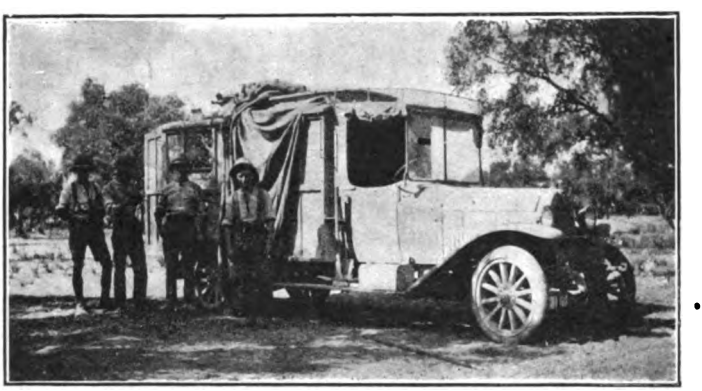
we find the new rulers of Germany radiating from Nauen wireless station messages about the fell intent of France and England, unjust action in extending armistice demands, etc., quite in the manner and with the same motives as the *ancien régime*.

GERMAN WIRELESS CONTROL.

The Bolshevists gained—and to a large extent maintain—their tyranny in Russia by their absolute control of Russian radiotelegraphy. No sooner is Kaiserism deposed from Germany and revolutionaries rampant, than we learn from Berlin sources that "the control of wireless stations in Germany is in the hands of the "Independent Socialist Party and the Spartacus group." According to this announcement, the Central Wireless management has fallen completely into the hands of Liebknecht and Ledebour. The Berlin News Agency further reports that, acting in conjunction with the Executive Council of the Workers' and Soldiers' League, the Central Wireless management succeeded in setting aside the Government, which has the greatest interest in controlling reports which are going abroad, and in constituting itself an independent authority. The Central Wireless managers, Herren Meyenburg and Hartmann, have answered this statement with the assertion that all German wireless stations are under the control of the people's mandatories, of all the interested Imperial Departments, and of the Executive Council, so that any misuse by any single party whatsoever is out of the question.



CAPTURED GERMAN WIRELESS. THE APPARATUS LORRY.

Why is it that the absolute control of wireless telegraphy is thus eagerly sought for? Partly, no doubt, that the people who are opposed to the men in power may not communicate freely between themselves or with sympathisers abroad. But mainly the idea is that through wireless they may control the Press. Germany has been long familiar with these methods of manufacturing (or stultifying) public opinion. It is a matter in which we have perforce had to imitate her during the war: let us hope that peace will soon see us quit of it. Press censorship and liberty cannot long continue side by side.

OUR ILLUSTRATIONS.

Considerable interest attaches to some of the trophies which have been taken from our beaten foe. Especially is this the case with the scientific instruments, the interest of which is likely to be permanent. In the immediate present the scientific experts working on our own side can satisfy a natural curiosity by observing the devices used by the enemy against whom they matched themselves. In later days, when the particular devices in question have become obsolete, these trophies will retain an historical interest—that which attaches to gear in use during a critical period of British military history. The pictures which will be found on pages 566 to 568 show the wireless gear utilised for field purposes by the Germans, and experts on our own side will be able to see from our prints sufficient details to enable them to grasp the particular form of the devices thus employed.

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Some Aspects of Radio Telephony in Japan

By EITARO YOKOYAMA

(Engineer of the Ministry of Communication, Tokio, Japan)

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(Continued from page 487 of our December issue)

INFLUENCE OF ELECTRODE MATERIALS ON DISCHARGE.

A DISCHARGER with copper electrodes, as shown in Fig. 2, was used at first. The secondary oscillation current produced in this case was not only very unsteady, but lasted only a few seconds. By replacing the copper anode by an aluminium one the secondary oscillations were greatly improved, as mentioned above. It is interesting to note that in the ordinary atmosphere a discharger with copper-copper electrodes gives stronger oscillations than one with copper-aluminium electrodes, though there is a little difficulty in starting the discharge in the former case.

A series of tests was made, several different metals being tried as electrodes, and it was finally found that aluminium was the best material for the negative electrode. With aluminium as a negative electrode and various metals as the positive electrode, the measurement of secondary oscillation current and corresponding primary supply current was made, other circuit conditions remaining the same. The results of these measurements are plotted in the curves of Fig. 14. It is noticeable in the curves that the combination of aluminium-aluminium electrodes gives the poorest result. This is probably due to the effect of polarity, dissimilar electrodes giving better result.

A series of experiments was also made with several different crystals (artificial and natural), such as silicon, carborundum, magnetite, zincite, etc., as electrodes. It is very interesting to find that there were several combinations of electrodes

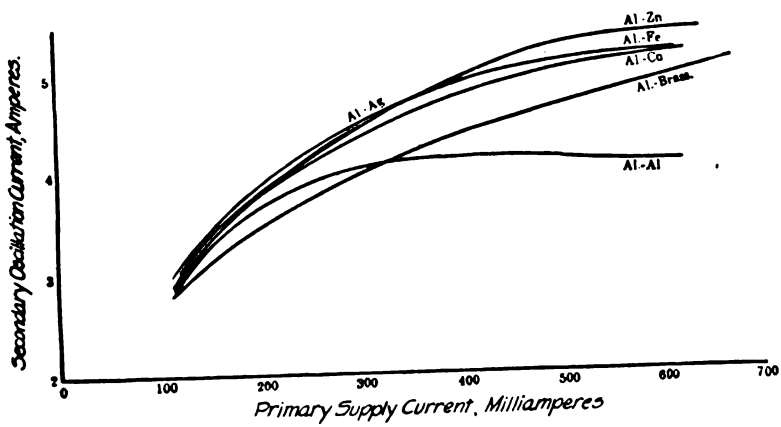

FIG. 14. OSCILLATION CURRENT PRODUCED WITH DISCHARGERS HAVING COMBINATIONS OF VARIOUS ELECTRODES.

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which gave very good results without the use of aluminium as the negative electrode. Generally speaking, the results with crystals were nearly the same as those with metals. However, it is very difficult to shape crystals into suitable forms; and since there is no necessity for the use of crystals as electrodes, the investigations were carried no further in this connection.

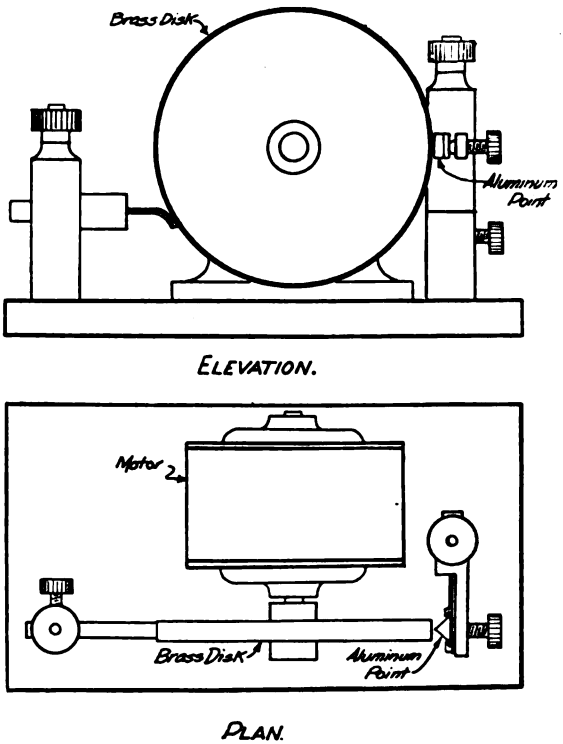

FIG. 15. T. KUJIRAI'S ROTARY GAP.

INFLUENCE OF SUPPLY VOLTAGE ON OPERATION OF DISCHARGER.

In the ordinary atmosphere a small clearance between electrodes is necessary to obtain continuously a discharge with a voltage less than 500. The use of so small a gap is likely to give rise to frequent short circuits. In the case of the use of such a gap in air it is necessary to insert a certain amount of resistance in series in the primary supply circuit in order to prevent short circuits which might injure some parts of the apparatus because of the passage of abnormally large currents. As described, the rarefied air discharge works well with a fairly wide clearance of electrodes in comparison with one at atmospheric pressure, though the shorter the clearance the better operation can be obtained. As the operating conditions prevent short circuiting, and the lack of air in the discharger doubtless greatly assists regular working, series resistance can be easily dispensed with, and a much lower voltage for the power source is sufficient for perfect functioning of the discharger. The experiment being made of varying the supply voltage from about 320 to 580, it was confirmed that equally good results were obtained at any point in this range of the supply voltage,

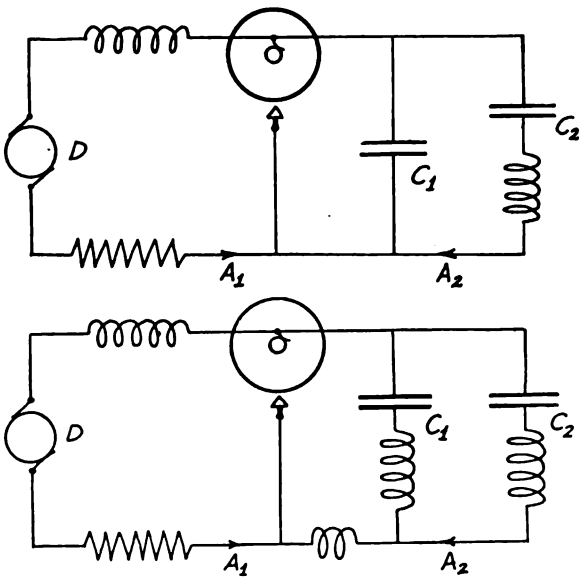

FIG. 16. CIRCUIT ARRANGEMENTS FOR THE ROTARY GAP.

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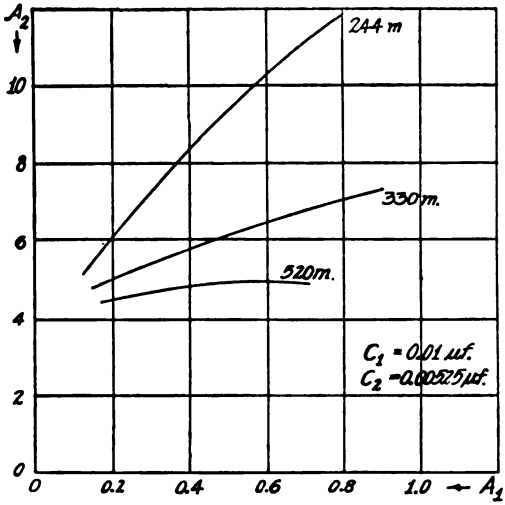

FIG. 17A. VARIATION OF OSCILLATION CURRENT WITH SUPPLY CURRENT.

the gap terminal voltage remaining nearly constant and in the vicinity of from 230 to 240.

Some Considerations Relative to the Life of Discharger.

Descriptions have already been given of the proper construction for the rarefied air discharger. In the long run deviations from good adjustment will occur even in a well constructed discharger, and the secondary oscillation current will gradually fall off. Some consideration will be given here to the causes of this effect and their remedies.

The life of the discharger depends largely upon its working in either stage (2) or (4). It has already been mentioned that stage (4) is much more suitable than stage (2) in a discharger with rarefied air as atmosphere, but the latter stage can be made equally as suitable by introducing a certain kind of gas in the discharger instead of air. Since the discharger working in stage (2) can be, moreover, operated through a much wider range of air pressure than when in stage (4), satisfactory operation in stage (2) is less effected by variation of pressure. A discharger in stage (2), with a special kind of gas inside, is therefore as good as and has a longer life than a discharger in stage (4) with air.

Supposing a discharger to have been well constructed, and with the precautions observed which have been considered under the several headings above, it will still finally reach the end of its life because of the pressure variation of the contained air arising from the following well-known causes: (*a*) Imperfect elimination of occluded gas from the metallic bodies, and of water vapour from the surfaces of these metallic bodies and the glass wall; (*b*) disappearance of gas due to discharge; (*c*) changes in electrode surfaces due to discharge.

The defect (*a*) can be eliminated to a certain extent by submitting the glass and the metallic bodies of the discharger to high temperature when constructed. As regards the defect (*b*), there seems to be no means whereby it can be perfectly cured, though it can be regulated by a method similar to that used for the adjustment of the "hardness" of X-ray tubes. As for the defect (*c*), the use of electrodes constructed as in Fig. 13 (*b*) makes the discharge steady for some time

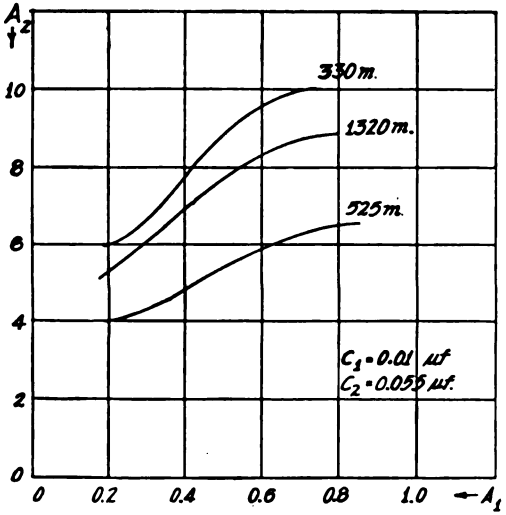

FIG. 17B. VARIATION OF OSCILLATION CURRENT WITH SUPPLY CURRENT.

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from the beginning, but the irregularity gradually increases in the long run, the smooth, straight line discharge altering into a poor discharge in the form of a brush. The discharge could be improved by covering the surface of the electrodes with a thin film of glass or enamel except at the centre of discharge surfaces.

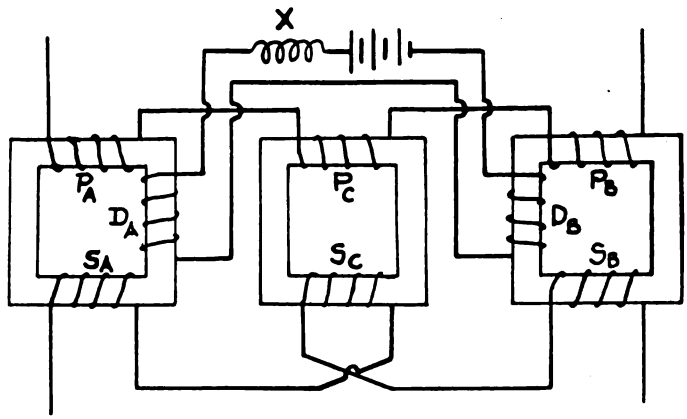

FIG. 18. ARRANGEMENT OF THE STATIC FREQUENCY TRANSFORMER OF T. KUJIRAI.

ROTARY GAP FOR RADIOPHONE TRANSMITTER.*

Mr. T. Kujirai has invented a kind of nearly sustained oscillation producer which is suitable for radio-telephone transmitters.

His first device was made public in Japan as early as 1910. The principal part of the apparatus consisted of a metallic or carbon rotary disc, directly driven by an electric motor, as one electrode, this being in light contact with a metallic or carbon brush as the other electrode; direct current being used as the power source. His sustained oscillation producer was a combination of the rotary gap and an ordinary oscillation circuit in shunt.

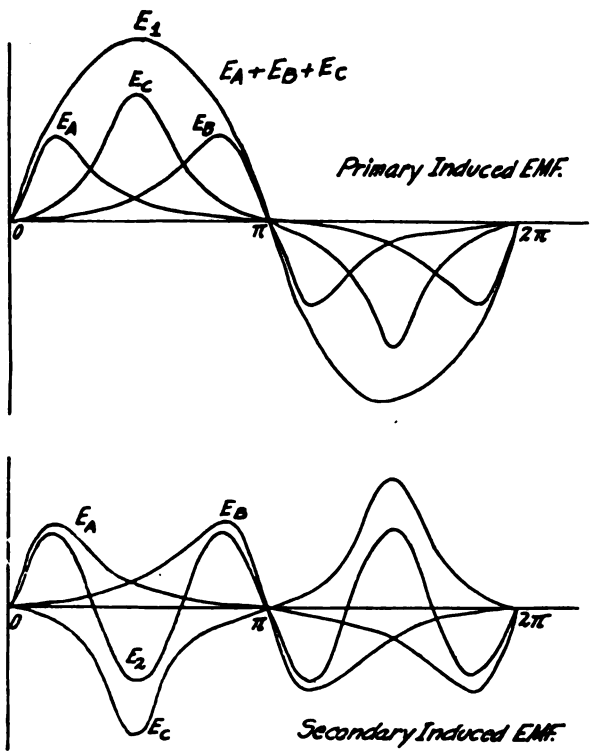

FIG. 19. DIAGRAM SHOWING THE PRINCIPLE OF KUJIRAI'S TRANSFORMER FOR TRIPLING FREQUENCY.

The apparatus has been successively improved, until he finally modified it in 1912, producing a form which is more suitable for radio telephone purposes. The latest arrangement consists of a rotary brass disc and an aluminium point, which is shown in Fig. 15. The circuit arrangements used by him in connection with his gap are shown in Fig. 16.

The power is supplied from a 500-volt direct current generator through a resistance and an inductance

* For much of the information here given the writer is indebted to the inventor.

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to a gap not greater than 0·5mm. (0·02 inch) in length. The supply current used in his arrangements varied 0·2 to 1·0 ampere, depending on the capacity in the oscillation circuit.

The frequency of oscillation may be varied through a wide range without affecting the stability of the discharge by varying one of the capacities in the oscillation circuit.

Figs. 17 (*a*) and (*b*) are sample curves showing the variation of the oscillation current with the supply current.

Using this arrangement, he is said to have succeeded in communicating articulate speech more than twenty miles (32 km.).

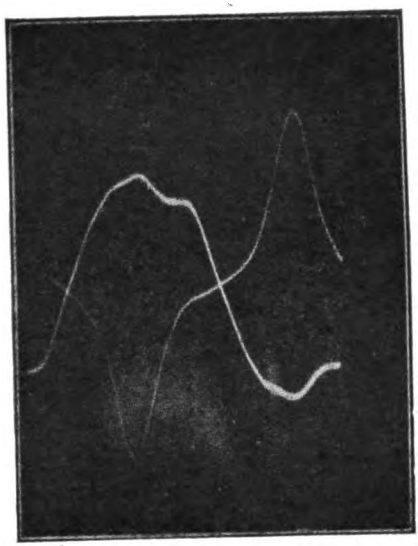

FIG. 20A.

Static Frequency Transmitter.*

Among others,† Mr. T. Kujirai has invented a method of tripling the frequency of an alternating current in 1915, which method was found to be very useful, not only in the common electrical engineering field, but also in radio telephony.

This static frequency transformer consists of three elements, two of which have their cores oppositely polarized by direct current through an inductance, X, and windings D_A, D_B, Fig. 18, while the third element is non-polarized.

The primary (P_A, P_C, P_B) and secondary (S , S_C, S_B) windings are respectively connected in series, but the secondary (S_C) of the non-polarized transformer element is connected in opposition to those (S_A. S_B) of the other two polarized elements.

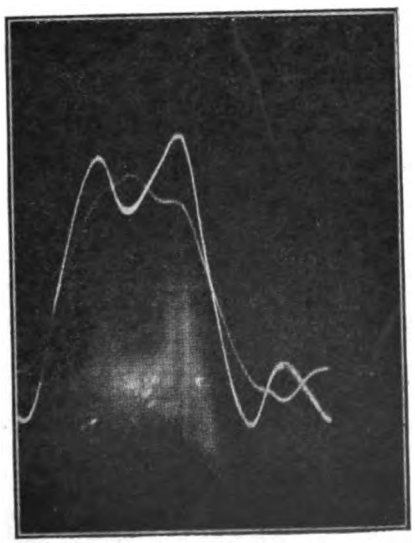

FIG. 20B.

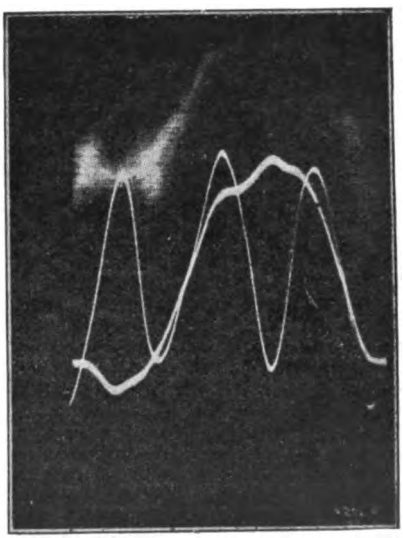

FIG. 20C.

FIGS. 20A, 20B, AND 20C. OSCILLOGRAMS SHOWING THE CONSTITUTION OF SECONDARY E.M.F. IN THE STATIC FREQUENCY TRANSFORMER OF KUJIRAI.

* For much of the information here given the writer is indebted to the inventor.

† See the paper "Radio Frequency Changers," by A. N. Goldsmith, "Proceedings of the Institute of Radio Engineers," March, 1915.

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The function of this arrangement is that the induced electromotive forces E_A and E_B (Fig. 19) in the secondary windings of the polarized transformer elements are asymmetrically distorted owing to the magnetic saturation of their iron cores, while the induced e.m.f., E_C, in the non-polarized transformer element remains entirely symmetrical, but remarkably peaked owing to the low magnetic density in its iron core. The distorted e.m.f.'s being superposed in opposition to the symmetrical one, the resultant of these e.m.f.'s will have such a form as E_2 (Fig. 19), which has a weak component of the fundamental frequency and a strong third harmonic, as well as higher harmonics.

Figs. 20 (*a*), (*b*), and (*c*) are oscillograms showing the constitution of the secondary e.m.f.; (*a*) is an induced e.m.f. in the non-polarized core transformer; (*b*) the resultant e.m.f. of the two polarized core transformers; and (*c*) the resultant of the e.m.f.'s of the three transformers. The oscillograms were taken by the inventor at University College, London.

Fig. 21 shows an example displaying the construction of a static frequency transformer which is now being used for experiments in radio telephony in connection with a radio frequency current alternator of the Alexanderson type in the Electrical Engineering Laboratory of Tokio Imperial University. The principal electrical data of the transformer are as follows:

Primary capacity	1·3 k.v.a.
Primary frequency	40,000 cycles.
Secondary frequency	120,000 cycles.
Primary voltage	260 volts.
Secondary voltage	120 volts.
Primary current	5 amperes.
Secondary current	3 amperes.

(*Concluded.*)

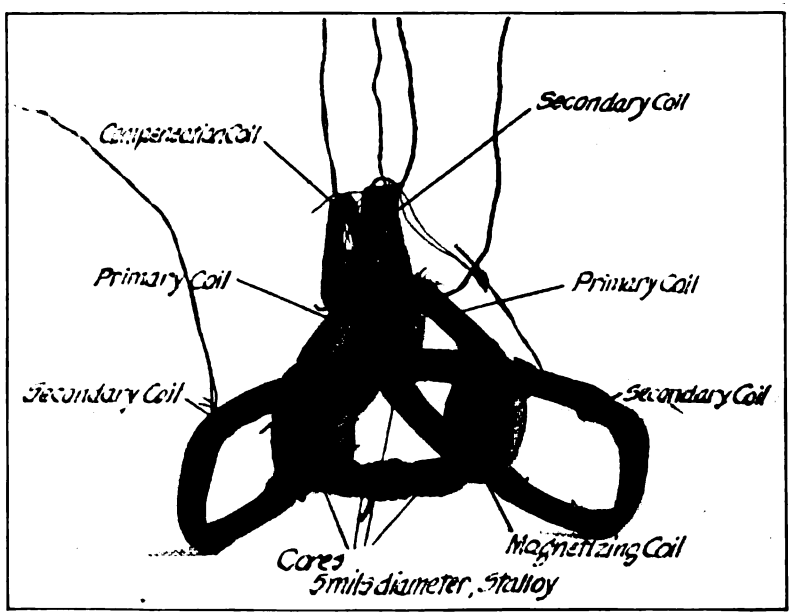

FIG. 21. STATIC TRANSFORMER WITH CASE REMOVED.

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Among the Operators

The recording of the first five names brings the list of the brave operators who have lost their lives at sea by enemy action, in the wireless service of their country, to a close. Messrs. Slade and Bartlett have lost their lives through misadventure at sea, and the death of the remainder mentioned this month has been due to natural causes. Both on our own part, and on that of our numerous readers, we extend to the parents and relatives of these young men, who so nobly upheld the "wireless tradition," the deepest sympathy in their sad bereavement.

MR. STANLEY OWEN LEWIS, formerly with Messrs. Evans & Evans, architects, of Pontypridd, was born in that town on May 24th, 1899, and educated at the intermediate school there. He was trained at the South Wales Wireless College, Ltd., Cardiff, and after gaining the P.M.G. Certificate, appointed to the operating staff in August, 1917.

Born at Greenwich on July 25th, 1900, MR. GEORGE HALTER was educated at Lombard Wall School, Charlton; South Church Hall School, Southend, and East Ham Technical College. After serving with the Western Electric Company, North Woolwich, as an instrument assembler, he trained at the East London Wireless Telegraph College, Forest Gate, E. He received the P.M.G. Certificate, and was given an appointment by the Marconi Company in May, 1917.

MR. ARTHUR HENRY JEFFRIES was born at Cambridge on April 24th, 1891, and went to St. George's School, Battersea, and St. Luke's School, Cambridge, for his education. Commencing his career as an apprentice to electrical engineering, with Messrs. B. Newton and Ward Brothers, of Cambridge, he attended the British School of Telegraphy, Ltd., London, and subsequently joined the Seaforth School of the Marconi Company. Mr. Jeffries's service dated from November, 1910.

Of London, MR. CLAUD CHRISTOPHER SELBY TUPPEN was born at Bayswater on December 8th, 1894. He received his education at Bedford Grammar School and the Royal Military College, Sandhurst. Attracted to wireless telegraphy, he trained at the British School of Telegraphy, Ltd., London, where he gained the P.M.G. Certificate. Mr. Tuppen was appointed to the Marconi Company's staff in April, 1916.

MR. WILLIAM JOSEPH MOLONEY was born at Limerick on July 6th, 1900. He was educated at the Munster and Connaught College, and received his training in radiotelegraphy at the Irish School of Telegraphy, Cahirciveen. On qualifying for the P.M.G. Certificate, Mr. Moloney was placed on the staff of the Marconi Company in May, 1918.

Looe, near St. Keyne, Cornwall, was the birthplace of MR. JAMES SLADE on December 21st, 1894. Commencing his education at Duloe Council School, he continued at Longmore Lane Council School, Liverpool. He was first employed by Messrs. Ellis Davies & Company, tea merchants, subsequently being trained in wireless telegraphy at the Liverpool Wireless Telegraph Training College. He won the P.M.G. Certificate, and joined the operating staff of the Marconi Company in August, 1914.

MR. GEORGE HENRY BARTLETT, born at Camberwell, London, on November 17th, 1899, was educated at St. Dunstan's College, Catford, and worked for his father's firm, Messrs. G. H. Bartlett & Company, export packing case manufacturers, of Hatton Wall, E.C. His wireless training was received at Marconi House School, and on receipt of the P.M.G. Certificate he proceeded to sea in the Marconi Company's service in December, 1917.

MR. FREDERICK ARTHUR ORMSON GUEST was born on June 9th, 1898, at Barnsley, and received his schooling there at the High School, Pannal Ash College,

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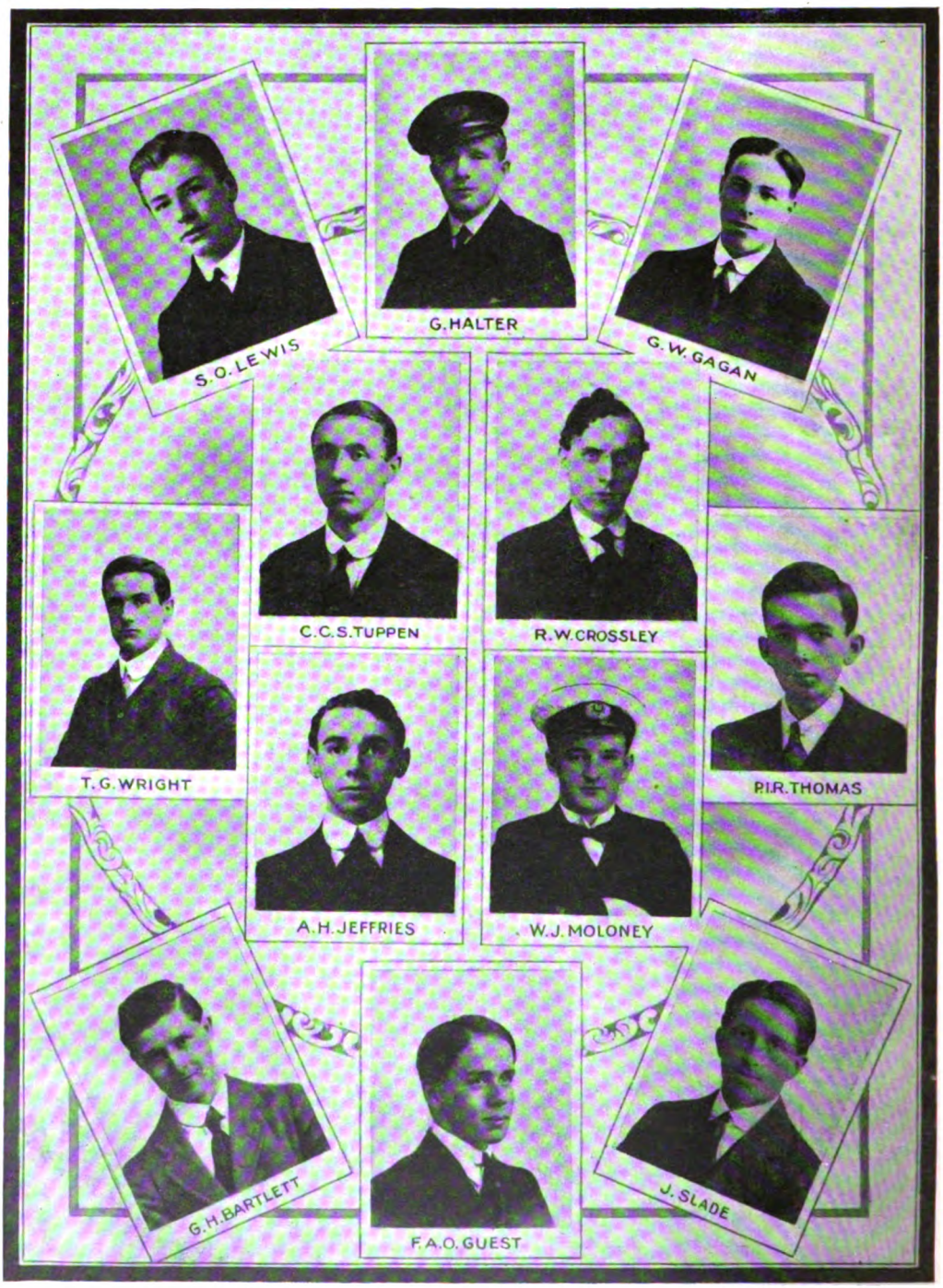
ROLL OF HONOUR.

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Harrogate, and Wakefield Grammar School. He was employed by Messrs. John Guest & Sons, Ltd., Barnsley, in his father's office, leaving to take up wireless telegraphy. Trained at the Manchester Wireless Telegraph Training College, Mr. Guest qualified for the P.M.G. Certificate and entered the service of the Marconi Company in February, 1917.

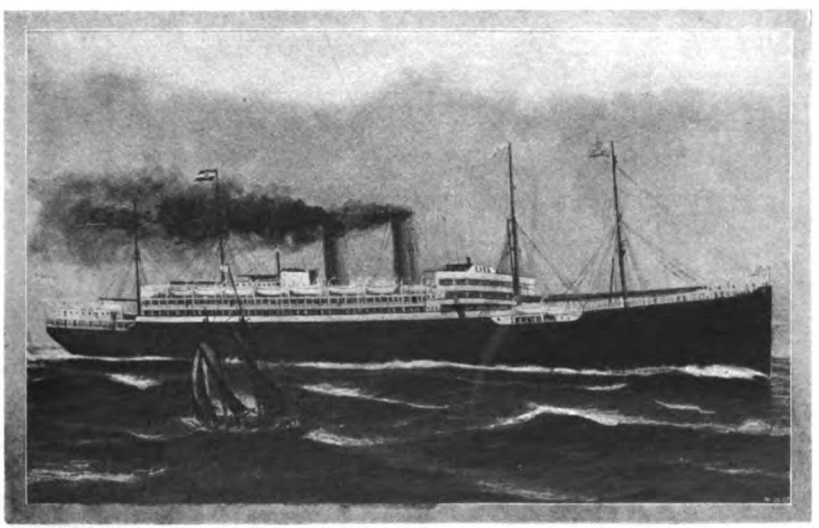
Born on July 3rd, 1895, at Putney, MR. GEORGE WILLIAM GAGAN was educated at All Saints' Upper Grade School, Putney, the London County Council School at Hotham Road, and afterwards employed as an assistant to a printer's reader. Trained in wireless telegraphy at Marconi House School, he obtained the P.M.G. Certificate, and joined the Marconi Company's staff in August, 1915.

Formerly a leading telegraphist in the Royal Navy, MR. THOMAS GODFREY WRIGHT was born at Wimbledon on January 7th, 1872, and educated at Oakland Road School, Anerley, and Mitcham Road Board School, Croydon. He served His Majesty four years, when he was invalided, receiving very good discharge papers, and entered the Marconi service in December, 1912.

MR. PHILIP IVOR RYCROFT THOMAS was born on August 17th, 1900, at Clifton, near Bristol, and attended Redland Hill House School, Bristol, for his education. His training in radiotelegraphy was received at the East London Wireless Telegraph Training College, Forest Gate, E., and on gaining the P.M.G. Certificate, Mr. Thomas was placed on the Marconi Company's operating staff in June, 1917.

MR. ROBERT WILLIAM CROSSLEY was born at Castleton, near Rochdale, on January 10th, 1897, and pursued his studies at the Trinity Wesleyan Schools. He was a student at the Manchester Wireless Telegraph Training College, and on receipt of the P.M.G. Certificate was appointed a sea-going operator in April, 1916.

The s.s. "George Washington"



[*Courtesy of "Syren and Shipping."*

THE VESSEL WHICH CARRIED PRESIDENT WILSON ACROSS THE ATLANTIC.

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Instructional Article

NEW SERIES (No. 10).

EDITORIAL NOTE.—Below we give the tenth of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

THERMO-CHEMISTRY OF THE SIMPLE VOLTAIC CELL (*Continued*).

Energy Transformations in the Voltaic Cell.—If a piece of zinc is put into dilute sulphuric acid an exothermic * action ensues; the metal disappears, hydrogen s evolved and zinc sulphate is formed. It is possible to equate the zinc and acid on the one hand to the products of the action on the other hand, thus:

zinc (**Zn**)	+	sulphuric acid (**H_2SO_4**)	=	zinc sulphate (**$ZnSO_4$**)	+	hydrogen (**H_2**)
one molecule	+	one molecule	=	one molecule	+	one molecule
one atom †	+	seven atoms	=	six atoms	+	two atoms

We begin with two molecules and have two molecules left; we begin with eight atoms and eight are left. As, however, we wish to take into consideration the evolved heat, we write the equation:

$$Zn + H_2SO_4 = ZnSO_4 + H_2 + 39{,}800 \text{ calories.}\ ‡$$

The third term on the right is the heat evolved during the formation of a **gramme-molecule** of zinc sulphate, where gramme-molecule is the molecular weight of zinc sulphate taken as grammes.

One molecule of zinc sulphate	1 atom of zinc, of atomic weight	65
	1 atom of sulphur, of atomic weight	32
	4 atoms of oxygen, each of atomic weight 16	64
Weight of one molecule of $ZnSO_4$		161

One gramme-molecule of $ZnSO_4$ = 161 grammes.

Now this heat energy, although not destroyed, is lost; it is not available for useful work and serves only to increase the temperature of the liquid and thus expedite the rate at which the chemical action proceeds. We cannot control it in the strict sense in which we control mechanical or electrical energy and it quickly passes beyond our reach. Now note that when zinc takes its place in our voltaic cell relatively very little heat is evolved in spite of the fact that precisely the same chemical action occurs. Indeed, if a plate of *chemically pure* zinc be used the temperature effect in the cell directly due to the formation of zinc sulphate is exceedingly small. It may well be asked, "But if the same exothermic action is

---

* The action *as a whole* is exothermic. Actually, the separation of the (SO_4) group from the hydrogen is endothermic, and this absorpt on takes place at the expense of the heat of the Zn—SO_4 combination. Hence, calories voltaically available = calories evolved minus calories absorbed.

† The zinc molecule is mon-atomic.

‡ Approximately.

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there, what happens to the heat ?" The reply is that *it is immediately set to work*, and that *where work is done energy is transformed*. For this heat energy of the chemical action in a voltaic cell performs work by causing the current to flow, or, as it is sometimes said, by forcing electricity up the potential slope from the zinc to the platinum. In other words, the heat is transformed into electrical energy.

Further, when the current passes through the circuit it does work with the result that another transformation of energy is effected, electrical energy being converted back into heat owing to the internal and external resistance.

We have now traced the potential energy through its various changes in a voltaic cell, and may draw the conclusion that the intensity of a cell depends upon the chemical action which is involved. The "life" of the cell depends mainly upon the amount of active material it contains—that is, upon the length of time for which the essential chemical action can continue ; but it is the amount of heat available to be transformed which, together with the temperature of the cell, decides its E.M.F. From this it would seem that it should be possible to build a cell with a very high E.M.F. by selecting those materials which would give a chemical action of high thermal value. Unfortunately the fact is that up to the present no voltaic cell giving an E.M.F. of much more than two volts has been produced. It is true that there are very many exothermic actions which correspond *in theory* to a much higher E.M.F., but in such cases the heat evolved is unavailable for transformation by voltaic means. For instance, when a mixture of iron oxide and powdered aluminium * is burned the heat evolved corresponds to a temperature of about 3,000 deg. C., but such an action cannot be turned to account in a voltaic cell.

CALCULATION OF E.M.F. OF CELL FROM THERMO-CHEMICAL DATA.

If we know the heat value of the chemical action which goes on in a voltaic cell we can calculate the E.M.F., though for very accurate work due account has also to be taken of the *temperature coefficient*, which is a ratio representing the rate of change of the E.M.F. with respect to the absolute temperature of the cell. To avoid the introduction of a mathematical idea not hitherto mentioned in these articles we will ignore the temperature coefficient.

Taking the case of our simple zinc-platinum cell, we know that 39,800 calories are evolved during the formation of one gramme-molecule of $ZnSO_4$, or what amounts to the same thing, during the solution of 65 grammes of zinc (*see* p. 578) in sulphuric acid. Therefore, the heat value of the solution of one gramme of zinc is $39{,}800 \div 65 =$ (say) 613 calories. We also know that if one ampere flows through the cell for one second ·000338 grammes of zinc are dissolved,† so that the amount of heat corresponding to the solution of this weight of zinc is $613 \times {\cdot}000338$ calories.

One calorie is the equivalent of $4{\cdot}2 \times 10^7$ ergs ; hence the energy of the solution of ·000338 grammes of zinc can be written

$$E = 613 \times {\cdot}000338 \times 4{\cdot}2 \times 10^7 \text{ ergs.}$$

This corresponds to the passage of one coulomb. Now if when one coulomb passes the work done is one joule (or 10^7 ergs) the p.d. is one volt. Hence we may write

$$E \text{ (in volts)} = \frac{613 \times {\cdot}000338 \times 4{\cdot}2 \times 10^7}{10^7 \text{ (or 1 joule)}}$$

$$= {\cdot}87 \text{ volts.}$$

As a general formula the following is applicable, though it does not take into account the temperature :

$$E \text{ (in volts)} = \frac{h\,z\,J}{10^8},$$

* The trade name of this mixture is Thermit.

† Because the electrochemical equivalent of Zn is ·00338 per e.m. unit, and therefore one tenth of this value per ampere—*i.e.*, ·000338.

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where h is the heat evolved in the cell during the solution of one gramme of Zn, z the electrochemical equivalent of zinc, and J the equivalent of heat in ergs.

CHEMICAL NAMES, SYMBOLS AND FORMULÆ.

The following table is not a full list of known elements, such substances as gadolinium, neodymium and other rare metals having been omitted because, apart from the subject of the Periodic Classification, they appear to be of small interest or utility. The weights of the atoms compared with the oxygen atom, which is taken as 16, are approximate:—

Name.	Symbol.	Atomic Weight.	Name.	Symbol.	Atomic Weight.
Aluminium	*Al*	27·1	Molybdenum	*Mo*	96
Antimony (*Stibium*) ...	*Sb*	120·2	Neon	*Ne*	20
Argon	*Ar*	39·9	Nickel	*Ni*	58·7
Arsenic	*As*	75	Nitrogen	*N*	14
Barium	*Ba*	137·4	Osmium	*Os*	191
Beryllium	*Be*	9·1	Oxygen	*O*	16
Bismuth	*Bi*	208·5	Palladium	*Pd*	106·5
Boron	*B*	11	Phosphorus	*P*	31
Bromine	*Br*	79·96	Platinum	*Pt*	194·8
Cadmium	*Cd*	112·4	Potassium (*Kalium*) ...	*K*	39·1
Caesium	*Cs*	132·9	Radium	*Rd*	225
Calcium	*Ca*	40·1	Rubidium	*Rb*	85·5
Carbon	*C*	12	Selenium	*Se*	79·2
Cerium	*Ce*	140·2	Silicon	*Si*	28·4
Chlorine	*Cl*	35·4	Silver (*Argentum*) ...	*Ag*	107·9
Chromium	*Cr*	52·1	Sodium (*Natrium*) ...	*Na*	23
Cobalt	*Co*	59	Strontium	*Sr*	87·6
Copper (*Cuprum*) ...	*Cu*	63·6	Sulphur	*S*	32
Fluorine	*F*	19	Tantalum	*Ta*	183
Gold (*Aurum*) ...	*Au*	197·2	Tellurium	*Te*	127·6
Helium	*He*	4	Thallium	*Tl*	204
Hydrogen	*H*	1·008	Thorium	*Th*	232
Iodine	*I*	126·9	Thulium	*Tm*	171
Iridium	*Ir*	193	Tin (*Stannum*) ...	*Sn*	119
Iron (*Ferrum*) ...	*Fe*	55·9	Titanium	*Ti*	48
Krypton	*Kr*	81·8	Tungsten	*W*	184
Lead (*Plumbum*) ...	*Pb*	206·9	Uranium	*U*	238·5
Lithium	*Li*	7·03	Vanadium	*V*	51·2
Magnesium	*Mg*	24·3	Zinc	*Zn*	65
Manganese	*Mn*	55	Zirconium	*Zr*	90·5
Mercury (*Hydrargyrum*)	*Hg*	200			

In most cases where the derivation of the symbol from the name is not apparent, the Latin name has been added. For example, it is difficult to see why tin is given the symbol Sn unless the Latin name for tin, *Stannum*, is shown.

An examination of the accompanying list of elements will show that they have not been named in accordance with any strict system. Some of them were known centuries ago and their names are connected with legends or are descriptive of some property they possess or were thought to possess. Oxygen, for example, was thought to be a constituent of all acids and therefore was named from the Greek *oxys* (acid) and the root *gen* (to generate). The word hydrogen is made up from *hydor* (water) and *gen* (to generate), whilst phosphorus is derived from *phōs* (light) and *pherō* (to bring). Magnesium is named after the place from whence magnesia was obtained, Magnesia, in Asia Minor. Copper is called Cuprum, a name derived from *aes cyprium* (Cyprus ore), so called because it was dug in Cyprus.

With regard to some of the more modern names an attempt has been made to systematise them, so that in order to distinguish between the non-metallic elements and the metals the latter have been designated by words terminating in the syllable *-um*. In the case of selenium and tellurium it may be noted that their names received this termination because these elements were formerly considered to be metals; they are now classed as metalloids.

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When we come to the names of compounds we find a much better state of things. In view of the enormous number of known compounds a generally recognised system of nomenclature is absolutely essential if confusion is to be avoided, and accordingly chemists have evolved names which indicate the *composition* of compounds, not only by combining the names of the constituent elements but by using an understood system of prefixes and final syllables of definite meaning.

In the case of **binary compounds,** that is, compounds made up of two elements, the names of the elements are simply brought together as in the following examples :

Potassium	combined with	iodine	Potassium iodide.
Calcium	,, ,,	oxygen	Calcium oxide.
Sodium	,, ,,	bromine	Sodium bromide.

It does not follow because two elements combine with each other that the resulting binary compound is always the same in composition, because some elements *will combine in different proportions.* For example, carbon combines with oxygen in the proportion of one atom of carbon to one atom of oxygen, forming carbon **mon**oxide, a gas which may often be seen burning with a blue flame on the surface of a coke fire in a grate with an insufficient draught. Yet an atom of carbon will also combine with *two* atoms of oxygen, forming carbon **di**oxide, a gas of quite different nature, being non-inflammable. Again, an atom of phosphorus combines with three atoms of chlorine, forming phosphorus **tri**chloride, and also with five atoms of chlorine, forming phosphorus **penta**chloride. Sometimes phosphorus trichloride is called phosphor**ous** chloride, and phosphorus pentachloride is called phosphor**ic** chloride, denoting respectively which compound contains the lesser and which the greater number of chlorine atoms.

When an element combines with oxygen the binary compound which results is called an **oxide.** *With the exception of hydrogen every non-metallic element will form an oxide which will combine with water to produce an* **acid.** Such acids are termed **oxyacids** and the oxides from which they are derived are called **anhydrides** or acid-forming oxides. Some elements will combine with oxygen in more than one proportion forming more than one anhydride, and to distinguish between two oxyacids which are formed from two anhydrides containing the same non-metallic elements but different amounts of oxygen, the syllables *-ous* and *-ic* are employed.

Examples :—

(1) **Oxides.**

Mercury and oxygen	Oxide of mercury.
1 atom of mercury and 1 atom of oxygen	Mercur**ic** oxide.
2 atoms ,, ,, 1 ,, ,,	Mercur**ous** oxide.

Note that the same -ous and -ic principle is applied also to distinguish between two compounds containing different amounts of a metallic element. Mercurous oxide is a very good example of an unstable compound ; the extra mercury atom is so feebly attached to the system that on exposing the substance to light it breaks up into the stable mercuric oxide and mercury.

(2) **Anhydrides.**

Sulphur (1 atom) and oxygen (2 atoms)	Sulphur **di**oxide.
Sulphur (1 atom) and oxygen (3 atoms)	Sulphur **tri**oxide.

(3) **Oxyacids.**

Sulphur **di**oxide and water	Sulphur**ous** acid.
Sulphur **tri**oxide and water	Sulphur**ic** acid.

There are other oxides, derived in every instance from a metallic element, which combine with water to form **hydroxides** ; these compounds all combine with acids

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to form **salts** and the oxides producing these hydroxides are therefore known as **basic or salt-forming oxides.**

Example :—

Calcium and oxygen	Calcium **oxide** (lime).
Calcium oxide and water	Calcium **hydroxide** (slaked lime).
Calcium hydroxide and hydrochloric **acid** ...	Calcium chloride (**a salt**) and water.

A certain number of acids contain oxygen—not all, as formerly believed—but the characteristic common to all acids is that they contain hydrogen. The four non-metallic elements, chlorine, bromine, fluorine and iodine, constitute a group called the halogen* group, each member of which produces an acid when combined with hydrogen. Being binary compounds these acids are called respectively, hydrochloric acid, hydrobromic acid, hydrofluoric acid and hydriodic acid. They produce salts which are also binary compounds and the names of these follow the usual rule.

Examples :—

Potassium and iodine	Potassium iodide.
Sodium and bromine	Sodium bromide.

Many elements will combine with sulphur to form binary compounds called **sulphides,** some of which, analogous to oxides, will form acids resembling the oxyacids in constitution, except that sulphur takes the place of oxygen ; these acids are called **thio acids.** "Hypo," so largely used in photography, is thio-sulphate of sodium, a **thio salt.**

The system of naming compounds which are not binary is as follows. The first part of the name is just the name of the metallic part of the base ; thus if the base is oxide of copper, the first part of the name of a copper salt is the name of that metal. The second part is a combination of the name of the acid with which the base is treated and either of the syllables **-ate** or **-ite.** If the name of the acid ends in **-ic** the name of the salt formed ends in **-ate** ; if the name of the acid used ends in **-ous** then the syllable **-ite** is suffixed to the name of the salt.

Examples :—

The basic oxide and nitr**ic** acid produce a nitr**ate.**
,, ,, nitr**ous** ,, ,, nitr**ite.**
,, ,, sulphur**ic** ,, ,, sulph**ate.**
,, ,, sulphur**ous** ,, ,, sulph**ite.**

When chemical action occurs between a base and an acid, such as between zinc and sulphuric acid, it is found that a certain number of the hydrogen atoms of the acid are replaced by a certain number of metallic atoms from the base ; in the particular case given one atom of zinc displaces two atoms† of hydrogen. It is not possible to replace *all* the hydrogen of *every* acid by metallic atoms and therefore those acids which contain only one atom of replaceable hydrogen are called **monobasic** acids. Following the same system the words **di-**basic, **tri-**basic and **tetra-**basic are used to describe acids containing respectively two, three, and four atoms of hydrogen which can be replaced by metallic atoms. Sulphuric acid is dibasic, nitric acid and hydrochloric acid are monobasic, whilst orthophosphoric acid is tribasic. Although an acid may be, for example, dibasic it does not necessarily follow that all the hydrogen atoms are replaced in a given action by metallic atoms. If they *are* all replaced

* Meaning "producer of sea-salt." So called because the compounds formed by sodium with these elements in some ways resemble sea-salt.

† $Zn + H_2SO_4 = ZnSO_4 + H_2$

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the resulting salt is called a **normal salt**; on the contrary, if the metal replaces only a certain number of hydrogen atoms and leaves some undisturbed the salt is styled an **acid salt.**

Example:—Sulphuric acid (H_2SO_4) is dibasic and the metallic element sodium will replace either one or both of the hydrogen atoms, giving in the first case **acid sodium sulphate** ($NaHSO_4$) and in the second case **normal sodium sulphate** (Na_2SO_4).

Chemical Symbols and Formulæ.

The symbols allotted to the elements are in some cases the first letter of their names—hydrogen, H, carbon, C, sulphur, S, and so on. In instances where the names of two or more elements begin with the same letter they are distinguished by symbols composed of the initial letter and the second, or in some cases by the initial and third letters. A glance at the table of elements will suffice to show the method which has been adopted.

Chemical formulæ are more than a mere indication of the composition of particular substances, for they show the *proportions* in which the atoms have combined. The symbol representing any element is understood to denote *one atom* of that element. Thus Zn means "one atom of zinc" and O means "one atom of oxygen." In order to represent a *molecule* of an element we must consider the number of atoms which compose it; this number is written as a subscript to the symbol. A molecule of zinc contains only one atom and might be written Zn_1, but it has been agreed that in cases of monatomic molecules the figure 1 shall *not* be written; hence the symbol Zn may be taken to mean "one molecule of zinc composed of one atom." Oxygen is di-atomic and therefore to represent its molecule we write O_2, whilst ozone, its allotrope, is O_3. In some formulæ the student will find elements whose molecules consist of more than one atom *represented by only a single atom*, such as in $NaHSO_4$; knowing that the hydrogen molecule is di-atomic he may wonder why H is allowed to be shown as an atom by itself. Of course, it is not actually alone although it is but a single atom. The molecule is the smallest particle of a substance *which can exist in a free state*, but the hydrogen in $NaHSO_4$ is *not* free but combined with oxygen, sulphur and sodium.

Turning to the question of compounds, the same rules apply. An example already familiar to us is that of sulphuric acid, the formula for which is H_2SO_4; this denotes "one molecule of sulphuric acid composed of seven atoms, namely, two of hydrogen, one of sulphur and four of oxygen." On examining this formula the reader may think it strange that we speak of it as being *one* molecule when, if O_2 constitutes a molecule, there are *two* molecules of oxygen present, not to mention the one molecule of hydrogen (H_2) and the odd sulphur atom. The answer to this difficulty is that we are now dealing with oxygen *in combination with other elements*, a very different thing to *free* oxygen, for its identity is merged in that of the acid and we cannot assume that its atoms stand in the same relation to each other or have the same motions as when in the free state. Free oxygen is gaseous but the oxygen in sulphuric acid does not display the properties of a gas; and free sulphur is yellow but the sulphur in the acid is not. It is true that in a molecule of H_2SO_4 there is *sufficient matter* to make up two molecules of oxygen, yet it should be easy to see that unless those four atoms are free from other elements and divided into two groups each one consisting of two atoms combined with each other in a particular manner, they can as little be regarded as two *molecules* as can a stack of bricks be regarded as a church. The same holds good in the case of the two atoms of hydrogen. It is the complete combination of the *seven* atoms which is the true molecule. If we liken two molecules of oxygen to a simple structure composed of four bricks we can compare the H_2SO_4 molecule to a more pretentious building, to help to build which the bricks of the simpler building have been pulled apart and used.

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To denote more than one molecule of a substance the necessary figure is placed before the symbol or formula.

Two molecules of oxygen are written	...	...	...	$2O_2$
Two ,, ,, zinc ,,	...	...	...	$2Zn$
Four ,, ,, hydrogen ,,	...	...	...	$4H_2$
Two ,, ,, sulphuric acid ,,	...	...	...	$2H_2SO_4$
Three ,, ,, zinc sulphate ,,	...	...	...	$3ZnSO_4$
Four ,, ,, water ,,	...	...	...	$4H_2O$

Remember that the figure *in front* of a formula applies equally to all the symbols; thus $4H_2O$ does **not** mean (4×2) atoms of hydrogen combined with one atom of oxygen but **four molecules** of water each of the composition H_2O—a total, therefore, of **twelve atoms**—*i.e.*, $(4 \times 2) = 8$ atoms of hydrogen and $(4 \times 1) = 4$ atoms of oxygen.

Certain instances are known in which a group of atoms in a molecule appear to be capable of acting as a single atom, that is, they seem to cling together during some chemical actions and act *as a group* in the same way as a single atom would. In such cases the symbols of the group are enclosed in brackets. $(NH_4)_2SO_4$ is the formula for **ammonium sulphate**, the figure 2 outside the brackets showing that there are two of these "compound atoms"—a phrase which is permissible only to express the peculiar behaviour of the (NH_4) group. The whole molecule contains fifteen atoms—*i.e.*, 2 of N, 8 of H, 1 of S and 4 of O. **Normal ammonium carbonate** is represented by $(NH_4)_2CO_3$. When this salt is exposed to air it decomposes into **hydrogen ammonium carbonate** and ammonia, the equation being—

$$(NH_4)_2CO_3 = H(NH_4)CO_3 + NH_3 \ (ammonia)$$
$$(14 \text{ atoms}) = (10 \text{ atoms}) + (4 \text{ atoms})$$

In this case, in accordance with the conservation law no atoms are made or destroyed, but a complex molecule splits up into two simpler ones. When normal ammonium carbonate is gently heated it decomposes much more completely into ammonia, carbon dioxide and water, four fairly simple molecules, as may be seen from the equation which is

$$(NH_4)_2CO_3 = 2NH_3 + CO_2 + H_2O$$
$$(\text{one molecule}) \ (2 \text{ mols.}) \ (1 \text{ mol.}) \ (1 \text{ mol.})$$
$$(14 \text{ atoms}) = (8 \text{ atoms}) + (3 \text{ atoms}) + (3 \text{ atoms})$$

Ammonium sulphocyanate is written $NH_4S(CN)$, which signifies that an atom of carbon and an atom of nitrogen seem to act together as one atom. We will give one more example of a formula containing the sub-group (CN), for in an earlier article* we referred to the conversion of ammonium cyanate into urea by the application of heat and pointed out that by the mere re-arrangement of the atoms in the molecule a substance is obtained differing greatly from the original. The equation of this remarkable action is as follows:—

$$(Amm.\ cyanate) \ (CN)O(NH_4) = (NH_2)_2CO \ (Urea)$$
$$(8 \text{ atoms}) = (8 \text{ atoms})$$

Here we have the same number of molecules (one) after the action as before it, and the very same atoms, yet a drastic alteration of the formula. This example is important not only because it presents a typical form of chemical action but also because it was the first case of the production of an animal compound by what may be termed artificial means.

* THE WIRELESS WORLD (November, 1918).

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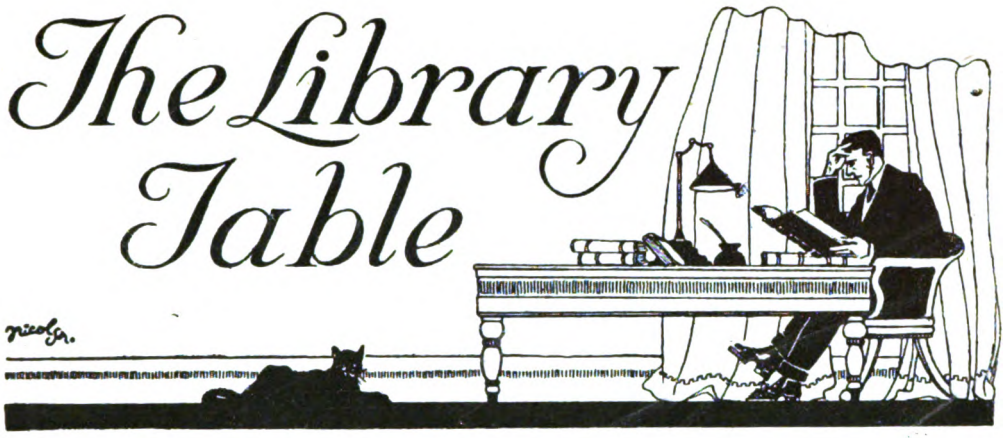
The Library Table



STANDARD TABLES AND EQUATIONS IN RADIOTELEGRAPHY. By Bertram Hoyle, M.Sc. Tech., A.M.I.E.E. London: The Wireless Press, Ltd. 9s. net.

Wireless telegraphy has now fortunately reached a stage when a vast amount of detailed information is available to the engineer and designer. The rule of thumb methods and the old tedious ways of trial and experiment in arriving at, for example, capacity and inductance values have long since been displaced by accurate formulæ, and it can safely be said that nine-tenths of the calculations of a modern wireless station of any power can be worked out with the certainty of accurate results. Whilst all the information necessary for such calculations is available to those who seek it, it has only now been brought together within the covers of a single volume, and Mr. Bertram Hoyle is to be congratulated upon the excellent way in which he has fulfilled his task.

There are a number of points in the general arrangement of the book to which we would like to draw the reader's attention. Firstly, we have in the case of some of the more difficult expressions a number of worked examples which will be particularly welcomed by those who are not well versed in the use of such equations, while a special point has been made in giving in every paragraph dealing with an equation a list of the meanings and units used in that equation. As is pointed out in the introduction, this has enabled the author to maintain the identity of the symbols and their meanings as used in certain equations of different authors, thus facilitating back reference to the originals when required. Secondly, the major portion of the extremely useful tables until now printed in *The Year Book of Wireless Telegraphy and Telephony* are included in the present book, together with numerous others abstracted intact from other sources or modified to suit the particular requirements of the present work, while several others are computed by the author himself especially for the volume.

The book opens with a lengthy and carefully compiled table of contents, which will greatly facilitate a search for information and save a great deal of time which would otherwise be spent in going through the main index.

In the first part of the book we find a number of generally useful formulæ and equations, followed by logarithmic and trigonometrical tables. Next follows a table of functions E and B used in calculating aerial capacity by Professor Howe's formulæ, followed by a table of function Q for use in Lorenz's equation $L_s = an^2Q$ cms., and a number of other tables of constants drawn from various sources. We then find some highly useful wire tables for copper, aluminium and resistance wires, together with tabular information on the effective resistance of copper wires carrying high-frequency currents of various frequencies. Space does not permit of our mentioning even a fraction of the total number of these formulæ and equations,

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and in fact an adequate review could only be given by quoting practically the whole of the table of contents. In addition to purely "wireless" information, a great deal of useful matter has been included of particular interest to engineers, such as wire gauges, screw threads, nuts and bolts, screw threads for gas and water pipes, pipe bends and tees, conversion charts for temperatures and so forth. It is worth while to draw attention to the "Notes on Elementary Arithmetic for Operators," wherein are contained a number of contracted methods of calculation of practical interest to many people other than operators.

"Indispensable" is a much abused word, particularly in regard to books, but we think that it can safely be claimed as an accurate designation of the work before us, which should be found upon the bookshelf of every wireless engineer, research worker and serious amateur.

THE L. S. D. OF FLYING AND THE PERMANENT WAY OF THE AIR. By Captain A. Swinton. London: The Aeroplane and General Publishing Co., Ltd. 6s. net.

This book, which happily appeared at a time when hostilities had ceased, is an attempt to place before the public the commercial side of peace time aviation and to educate the man in the street in the matter of the commercial aspect of flying. The subject being very much "in the air," it is inevitable that the author should draw largely upon his imagination for the figures given, and we have no doubt that many will be found to disagree with some of the statistical statements. This, however, is inevitable in any such pioneer work, and as only actual experience gives us some reliable figures, we must, of course, accept theoretical "approximation."

Chapter I, entitled "The Uses of the Flying Machine," contains a general survey of the subject, and, although we think that several of the author's arguments are laboured and set out to prove what is already generally accepted, it will nevertheless serve to remove many misconceptions. In passing, we may mention that on page 15 the author thinks he has coined a new word, "aerogram." We would point out that this word was coined many years back in the United States by a commercial wireless telegraph company, and was printed in large letters upon the top of every one of their telegraph forms. In addition to this, the word is in common use by journalists in the United States as a variation on marconigram, and its introduction as a word describing a message carried by aeroplane is therefore not to be encouraged.

Chapter II—"A Glance Backwards"—is purely historical and seems a little out of place in this volume, save for the few paragraphs at the end dealing with aviation immediately prior to the war. Elementary technicalities and types of machine are dealt with in Chapter III, and a special word of commendation is due to the excellent illustrations. Further chapters deal with trade considerations, the "Permanent Way" and its cost, running costs, the mails of the world, and the State and flying. In the chapter on permanent way cost very detailed estimates are given, and it is here particularly that criticism will be directed by many readers. For example, in a consideration of a London-to-Sydney scheme, where most of the flying is oversea, we find figures worked out for 60 alighting and refilling stations, land—two acres each—is estimated to cost £5 per acre, and this multiplied by 60 gives the total cost of land as £600. We do not know on what the author has based his estimate in this matter, but seeing that the aerodromes will naturally require to be as near as possible to commercial centres, and seeing that there will be great competition for suitable sites, the figure of £600 for the land would seem to be a long way out. Similarly the cost for sheds, quarters, slipway, motor launches, searchlight and wireless accommodation is estimated at £3,000 per station, which seems to us to be very much on the low side. Many other of the detailed estimates are open to similar criticism, and when we consider that each one of the items, and

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consequently the possible error, is multiplied by 60, the approximate total is so unreliable as to be absolutely useless.

Many of the problems to be met with in commercial aviation are passed over quite lightly, and we are much interested in the author's statements under the heading of "Fog." "With regard to the question of fog," says Mr. Swinton, "the author does not think that this is such a very serious matter. Aeroplanes "are to be directionally controlled by wireless; when this control is brought to "the pitch of exactitude required, it will not be necessary for the pilot to see his "way, as he will be automatically steered from point to point by a system of radio-"telegraphy; these waves would not be materially affected by fog or by rain or "by any other conditions of the atmosphere. It is probable that collisions will "be avoided by the same means. The question therefore of being able to see does "not appear to matter as much as one might think." On this quotation comment seems needless!

Chapter IX, which deals with the "Aerial Ford" and the "Aerial Taxi," endeavours to establish a parallel between the Ford car and the aeroplane in regard to quantity production. Having explained that Mr. Ford made it possible to buy a reliable fully equipped five-seated motor-car for the sum of £125, when previously no car of a similar performance could be bought anything like so inexpensively, the author goes on to say that if such cars can be produced so cheaply there is no reason why the cost of aeroplanes should not be brought down in the same proportion. We think this argument is based on a fallacy. A great deal of the success of the Ford car has been due, as Mr. Swinton points out, to simplicity and cheapness of construction as opposed to beauty and æsthetic distinction, but it must not be forgotten that the interchangeability of parts and the possibility of obtaining replacements for broken parts in practically any town has also contributed to its commercial success. Let us, however, consider the case of an aeroplane. "Finish" on a motor car may be a luxury. If the non-wearing portions of the axle are rough or smooth this makes no difference to the speed at which the car will run or its liability to break down; "finish" on an aeroplane may make all the difference to speed, and the difference between a rough and a smooth strut may mean the difference between an inefficient and efficient machine. The high degree of efficiency in a modern aeroplane is undoubtedly due to handwork, and the careful tests which have to be applied to even the most minute portion of the machine must militate against the success of quantity production. There is all the difference in the world between a breakdown on the road and a breakdown in the air. In the one case it means but temporary inconvenience and delay; in the other it would probably mean death and destruction to crew and machine.

In spite of its faults, however, the book is to be welcomed as a courageous attempt to tackle problems which must be faced sooner or later, and at this time when the newspapers so frequently publish accounts of commercial flying schemes, it is well that we should have a work of this nature to stimulate our thoughts.

Share Market Report

LONDON, *December 12th*, 1918.

BUSINESS fell off considerably in the shares of the Marconi groups during the last month in sympathy with other markets. In spite of this the prices are fairly steady. Marconi Ordinary, £4 12s. 6d.; Marconi Preference, £3 12s. 6d.; Marconi International Marine, £3 10s.; Canadian Marconi, 13s. 6d.; American Marconi, £1 11s. 3d.; Spanish and General, 14s. 6d.

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Personal Notes

Promotion.

Lieutenant G. Ferney Steven, of Berwick, mentioned in despatches for services in the field, has been promoted Captain. He joined up at the commencement of hostilities, being then seventeen years of age, leaving his studies at the Royal High School, Edinburgh, for the purpose. When trained, he qualified as a First-Class Army Signaller, and was attached to the Lothian Brigade Signal Section. Later he was gazetted Second Lieutenant in the Northumberland Fusiliers, and subsequently transferred to the Wireless Training Centre, Worcester, qualifying there as Wireless Officer, R.E. Captain Steven is the younger son of Major Steven, T.D., editor of the *Berwick Journal*, and served for two years in France.

Matrimonial.

A pretty ceremony was witnessed at St. John's Church, Newlands, near Hull, on October 24th last, when the marriage of Mr. Sydney Stansbridge and Miss Doris May Cragg, of Hull, was solemnised. Inspector Stansbridge, who is acting as representative of the Marconi International Marine Communication Co., Ltd., at Hull, and his bride received as a wedding gift a pair of silver castors and a combination breakfast dish, with the congratulations and hearty good wishes of his colleagues.

MR. AND MRS. S. C. ANSELMI.

On November 2nd, at Oakfield Baptist Chapel, Sale, Cheshire, the wedding took place of Mr. Silvio Calvin Anselmi, one of Marconi's Wireless Telegraph Company's engineers, and Miss Doris Mary Battersby, of Sale. Mr. Anselmi has during the past three years been engaged on naval installation work in Spain, and recently returned to headquarters. Another of the Company's engineers, Mr. W. B. Cole, officiated at the organ.

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Questions & Answers

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules :* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions, readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (6) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

J. L. (Helensburgh).—(1) At the present time the Marconi Company are not accepting learners, but only men who are in possession of the Postmaster-General's first-class certificate. (2) This is answered in one. (3) This depends on your telegraph speed, but, assuming that at the time you sat for the examination your speed was only just sufficient to pass for the second-class certificate, and supposing that you apply yourself diligently under suitable instruction, the time taken should be, roughly, from two to three months.

F. H. F. (H.M.S. ——).—We do not know from what source you gathered the totally erroneous information given in your letter that discharged naval operators will not be accepted for the Marconi service on the grounds that, after being on the lower deck of a warship, his social position would not be good enough. Candidates for the Marconi service are accepted purely on their own personal merits and knowledge. Snobbery of this nature had, we thought, been killed by the war; certainly it has no influence upon the selection of wireless operators for the Marconi service.

ERB. (Bardon Hill).—The instruction you have received and the knowledge you state you possess would considerably shorten the period it would be necessary for you to spend in a wireless school in order to obtain your P.M.G. first-class certificate. As mentioned in our reply to J. L. (Helensburgh) above, at the present time the Marconi Company are not accepting learners, and, therefore, if you wish to enter their service as a wireless operator, it will be necessary for you to obtain a first-class certificate, and place your name on their waiting list.

V. M. A. (Brocton).—(1) The Marconi Company has no boarding school. (2) See our advertising columns. (3) About nine months. (4) The terms depend upon the particular school which you select, and would no doubt be reduced if you explain the degree of knowledge which you possess of telegraph operating. (5) To answer this question would be in effect to give you a complete statement of the Conditions of Employment for Wireless Operators, which obviously cannot be done in the space at our disposal. If you communicate with the Traffic Manager, The Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C.2, he will forward to you these conditions of employment, which will explain themselves.

Y. L. S. (Guildford) asks:—In a cage aerial, or any aerial of more than one wire, is there any mutual repulsion between the charges of each wire, as they are of the same polarity, and, if so, does it have any practical effect?

Answer.—This repulsion exists, but is not marked, and does not in any case have a practical effect on the construction of the aerial. Our correspondent is probably aware of the fact that the addition of extra wires to an aerial does not increase the capacity proportionately. For example, if two more wires are added between the twin wires on the ordinary ship's aerial the capacity is not doubled.

U. D. (S.S. ——).—All the information you desire regarding the society in question is obtainable from The Secretary, Institution of Electrical Engineers, 1, Albemarle Street, London, W.1. With regard to your second suggestion for the arrangement of apparatus on the wall of the silence cabin, why not put this to the Suggestions and Inventions Committee? If it is novel and practicable you will thus obtain credit for it, and if not, you will probably be told the reason.

W. J. H. (Southampton).—The matter to which you refer is somewhat complicated by reason of differences in design, and differences between the fixed and rotary dischargers when used in conjunction with the 1½ kw. set. It is an undoubted fact that in order to get the maximum *efficiency* from the set the L.F.I.C.I. must be carefully adjusted. The fact that in some cases taking out the L.F.I.C.I. increases the current in the low frequency circuit sufficiently to blow the fuses is no indication that one is getting greater radiation, as the power factor of the circuit may be lower. The quality of the spark may also be considerably modified by such a change, so that signals may not be so clearly audible at the distance at which it is desired they should be received.

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When the disc discharger is used in place of the fixed gap there are additional factors to be taken into account.

KNOWLEDGE (Elswick).—(1) The objections to making a condenser with sheet iron plates instead of zinc or copper are several. The first and most important relates to the magnetic properties of the iron, which would set up loss due to hysteresis. Secondly, if it were an air condenser one would get the effects of the atmosphere upon the iron, resulting in rust and other forms of oxidation. In the case of a condenser immersed in oil, unless both iron and oil were of a high degree of purity, one would expect the plates to be eaten away much more quickly than the other metals. Thirdly, it must not be forgotten that the conductivity of iron is less than that of copper, and the resistance losses will, therefore, be higher. (2) The billi condenser is merely a variable condenser of very small capacity obtaining its name from the fact that its capacity is usually in the order of billionths of a farad. There are several formulæ for calculating the capacity of condensers made up of two concentric cylinders. If the distance between the cylinders be small compared with the leads, the capacity per unit length is

$$C = \frac{\frac{1}{2} K}{\log_e \frac{r_2}{r_1}}$$

where K = the dielectric constant of the dielectric between the cylinders, and r_1 and r_2 are the radii of the inner and outer cylinders (see *Calculation and Measurement of Inductance and Capacity*, by W. H. Nottage, page 46). (3) The object of the condenser in the circuit which you illustrate is to make the circuit periodic. It can thus be brought into resonance with the intermediate circuit of the multiple tuner, giving a degree of selectivity which would be impossible without it.

E. W. S. (Hull).—Youths in training at the Marconi Company's London School commence without pay, but after they have made some progress and can pass a certain series of tests, they are paid at the rate of 5s. per week. At a later stage, and on passing a further test, they are paid 17s. 6d. per week, and immediately upon obtaining their first-class P.M.G. certificate receive 30s. per week. As the Marconi Company are no longer accepting students for free training, but only those who have already passed the P.M.G. examination, all men now entering the London School are paid 30s. per week for the short period they remain there in order to become acquainted with the Company's own methods and clerical work. The Marconi Company does not provide food and sleeping arrangements for their students, but a Welfare Department exists, from which can be obtained on application a list of approved apartments and boarding houses, together with any other information and advice which the students may require.

M. J. (Ramsgate).—As stated above, the Marconi Company are not now accepting men for free training. With the knowledge you possess, the time required to complete your studies and obtain a first-class P.M.G. certificate would not be long, but, of course, you would have to be prepared to take your chance on any waiting list which may exist at the time you receive your certificate. With all the problems of demobilising, resignation of operators who desire to return to their old occupations now that hostilities have ceased, and other factors, it is even more difficult than previously to forecast what the Company's requirements are likely to be, but if you are prepared to wait for a period after obtaining your certificate, we should imagine that you would have a fair chance of employment, provided, of course, you are physically fit and otherwise suitable for the Company's service.

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SPECIAL NOTE.

THE MARCONI FREE TRAINING SCHEME IS NOW CLOSED.

Correspondents who wish to train as Wireless Operators should apply to the nearest Wireless Training School or College.

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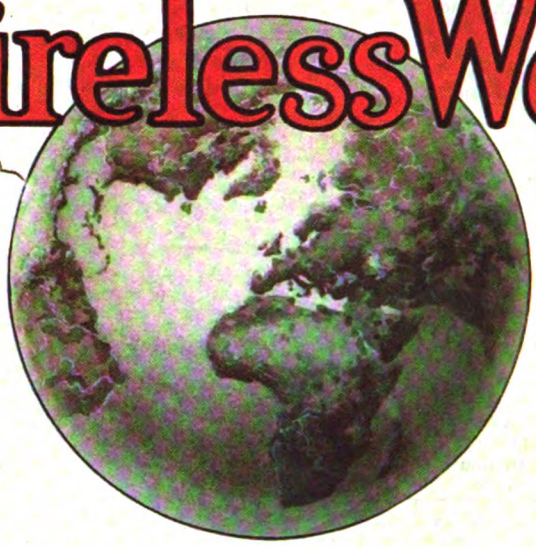

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The
WIRELESS
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Volume VI. No. 71. FEBRUARY, 1919.

Great Wireless Stations of the World

I. Stavanger Radio

By JULIUS GALSTER, Engineer-in-Charge

In Norway the importance of wireless telegraphy was grasped at an early date. The long and dangerous coast line frequented by numerous vessels, the important shipping centres which here find a home, and the hundred and one fishing stations dotted all along the seaboard would otherwise have to rely upon extensive cable connections constantly liable to fracture. As early as 1900 the Norwegian authorities despatched an engineer to London to study the Marconi system, and in 1901 the Norwegian navy made their first experiments. After the first connection had been established between the fishing stations at Sörvaagen and Röst a number of other installations were erected at various points south of the North Cape. The next step was to erect a long-distance station. Matters were arranged between the Marconi Company and the Norwegian authorities in August, 1912, the scheme being ratified in June, 1913.

The Transmitting Station.

The " Timed Spark System " is employed, and the station constitutes one of the most powerful yet erected by the Marconi Company. A 500 h.p. motor drives two 150 k.w. 5,000-volt continuous-current machines, which charge a condenser battery of about two microfarads. This is discharged across the disc. The spark gap is, however, so long that the main spark does not form until a smaller control

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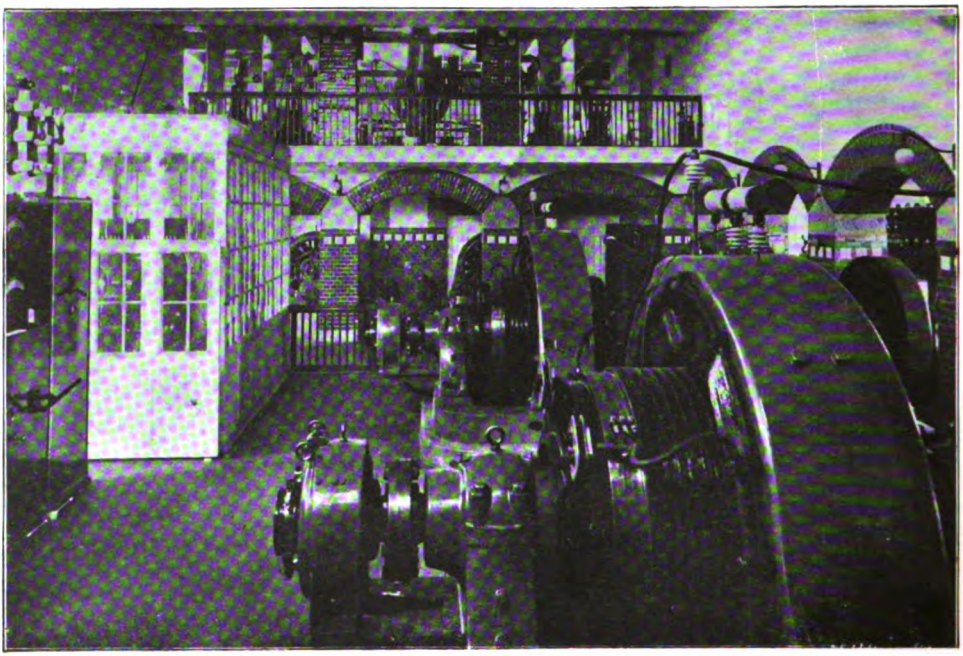

A VIEW IN THE MACHINERY HALL. ABOVE, IN THE GALLERY, PORTIONS OF THE TRANSMITTER CAN BE SEEN.

spark has crossed the gap and ionised the air. The oscillations thus induced pass through the jigger primary, from which they are transferred by induction to the jigger secondary, one end of which is connected with the earth, whilst the other passes through the aerial inductance coils to the aerial. The latter is of the inverted L-type and directional, radiating the energy most strongly in the direction of the angular point of the L.

The discharger consists of three large steel discs with copper teeth. One of these discs—known as the trigger disc—does the work of ionising the air in the main spark gap. The other two discs each contain 24 teeth, and are so placed in relation to one another that impulses arise from the oscillations of one before those in the other have died away. These machines rotate with a speed of rather more than 2,000 revolutions per minute.

The station is arranged for duplex work—*i.e.*, it can send and receive telegrams simultaneously to and from its linked American station, which is located in the neighbourhood of Boston. This result is attained by the interposition of a considerable distance between the receiving and transmitting aerials combined with a differentiation in wave-length. The receiving station has been placed at Naerland, about 16 miles south of the transmitting apparatus, which is located just outside Stavanger. The wave-length on which messages are received from Boston is 50,000 ft., whilst that employed for radiation by Stavanger is 30,000 ft.

The transmitting station lies on a heathery moor that slopes towards the historic Hafrsfjord. The area covered is approximately 1,320 yards long by 330 yards wide; so that it can easily be understood that the task of erection presented a formidable problem. Before being able to make any headway it was found necessary to lay down roads and erect a small quay on the margin of the fjord. By August, 1913, work had progressed far enough to allow of the transport of sand and shingle to the destined site of the masts, and the foundations were duly laid. By the new year the operation of erecting the ten 400-ft. masts was

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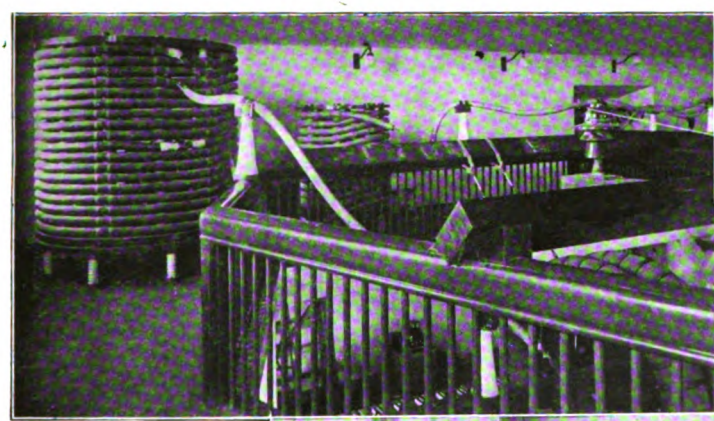
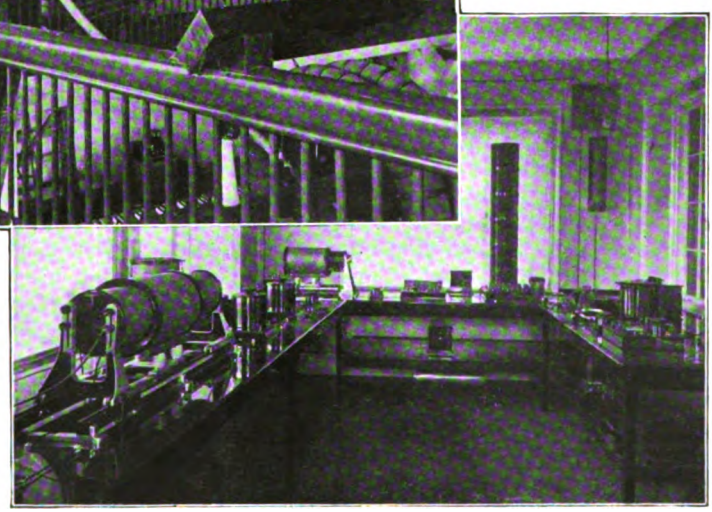
proceeded with. They were arranged in two rows of four. At the further extremities, where these masts are exposed to increased strain on account of the aerial's downward slope, a middle mast was intercalated. The aerial supports are of tubular construction, built in sections of semicircular rolled plates ⅜ in. thick, bolted together. They are calculated to be able to stand a top strain of 2 tons and a wind pressure of 30 lb. per square foot. The masts, which are of the well-known Marconi tubular steel variety, were erected on their bases, thus obviating the difficulties of hauling into place so tall a structure.

The masts are stayed to four large bases with six sets of stays composed of 3-in. wire. Each stay is divided into several sections by insulators. These came from England already fastened together, so that it was only necessary to insert the last splice on the spot. These insulated stays are tested for a pull of 13 tons. Large 2-in. rigging screws secure them to the foundation irons. Between each pair



ABOVE.—THE AERIAL TUNING INDUCTANCE AND AERIAL LEAD-IN.



BELOW.—THE RECEIVING ROOM. THE TALL OBJECT IN THE BACKGROUND IS A LARGE INDUCTANCE FOR RECEIVING LONG WAVES.

of masts stretches a 1½-in. steel wire supporting the aerial. Each aerial wire is 400 ft. long, and is made of silicon-bronze. The aerial is separated from the supporting wires by insulators a yard in length.

Earth connection plays an important part in the effectiveness of every station, and the earth-net therefore received careful attention. It consists of an outer and an inner ring of galvanised iron plates, well buried in the earth and connected together with copper wire. From the outer ring of these plates a number of copper wires are led under the mast for the whole length of the site.

The station building, 30 yards by 16, is constructed of granite blocks. This was already completed before the outbreak of war.

For the transmitting work of the station a power of 400 k.w. is required. This is derived from the Stavanger Electric Station, which delivers a current of 5,200 volts through a direct line carried overhead for the first part of its journey and

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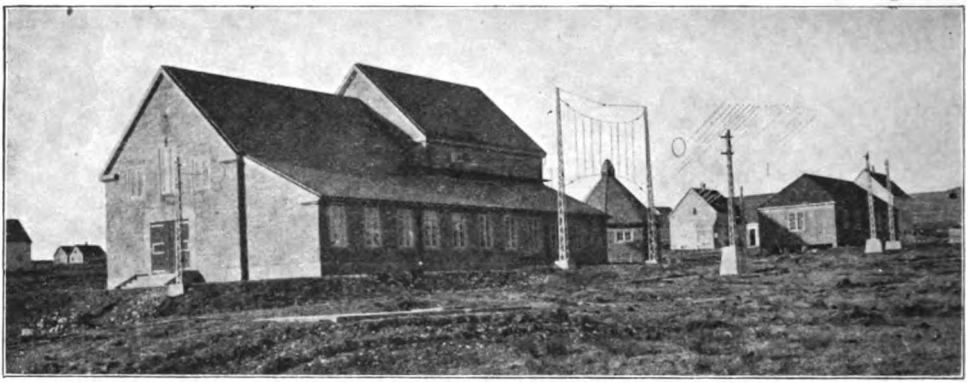
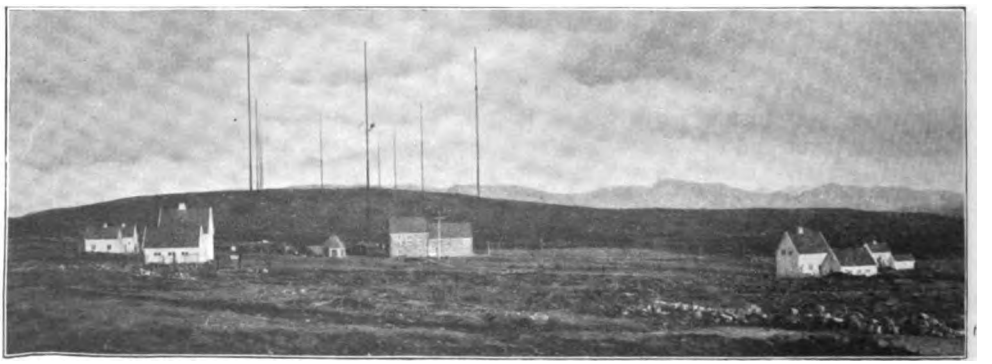


THE TRANSMITTER HOUSE AT STAVANGER, SHOWING THE AERIAL LEAD-IN.

during the last mile by underground cable. In the transformer house of the radio station this voltage is converted to 440, and the current is then transferred to the low-tension switchboard in the station building. A 500 h.p. synchronous motor drives two 150 k.w. high-tension continuous-current dynamos. The high-tension machines are placed on insulated foundations, the dynamos being furnished with separate exciter machines.

The discharger, to which we have referred already, is driven by a continuous-current motor, supplied by a special motor generator. On the second storey stands the condenser battery, which consists of about 200 condensers connected partly in parallel and partly in series, each condenser being made up of square zinc sheets separated by glass plates, all of which are contained in porcelain tanks filled with oil.

The jigger primary is built up of stranded wires, which are wound in spirals over a cylindrical wooden former. Into this former the jigger secondary can be shifted so that the coupling between the closed and open circuits can be changed. Between the aerial lead-in and the jigger secondary are located different coils utilised for varying the wave-lengths. To prevent the formation of an arc air is blown into the spark gap. This air is introduced at a pressure of 40lb. As the disc room becomes heated it is necessary to use fans for the renewal of the air. The high-tension key is placed in the trigger circuit and is manipulated from the receiving station, which is connected through a double line with a relay at the transmitting station. The high-tension key itself breaks a current of 5,000 volts, at the approximate rate of 2,000 times per minute when automatic transmission is being



A VIEW OF THE MASTS AND BUILDINGS AT STAVANGER.

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used at the speed of 100 words per minute. Compressed air has also to be used here in order to prevent the formation of an arc.

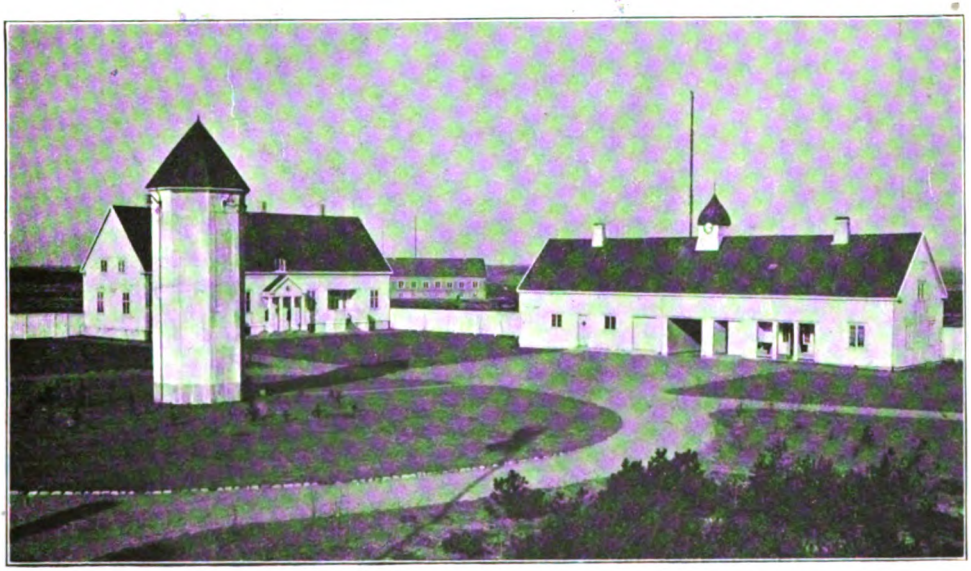
The Receiving Station.

Here the masts are placed in one row and only 300 ft. high. The aerial consists of two wires 8,500 ft. long. The earth-net is also smaller than that of the receiving station. The receiving apparatus constitutes an excellent specimen of the latest type of Marconi instruments for long-distance reception. Hand-sending is dealt with in the ordinary auricular fashion; but when automatic sending is being dealt with the speed becomes too much for ear and hand, and phonograph records are here utilised. These are subsequently taken over and set on machines running at a slow speed, so as to enable the operator to interpret the signals. A detailed description of the receiving apparatus is impossible here. It is only necessary to remark that the work is carried on with the highest efficiency, and that signals from America are, by the utilisation of the latest magnifier, brought to such a degree of strength that it is almost impossible to keep the telephone to one's ear.

Though there is a great difference between the length of receiving and transmitting waves, it was found advisable to make special provision against possible interference by the neighbouring transmitting station. This is effected by the balancing aerial, which consists of wire carried by seventeen 100-ft. wooden masts. By a simple coupling between coils, combining signals from both aerials, it is possible to cut out any interference.

In view of the permanent character of this station the Norwegian authorities have taken care to provide for the comfort of their operators. The buildings have been specially designed for this purpose, and the staff owe much to the care with which the Telegraph Director, Mr. Heftye, has bestowed upon this side of the matter.

The provisional tests were made in March and April of this year, but in view of the taking over by the Federal authorities of all wireless in the U.S.A., the Boston station has not been able to start its commercial intercourse with Norway, and we are still awaiting the time when we may expect a vast influx of traffic, so desirable from the point of view of international commercial intercourse.



SOLIDITY OF CONSTRUCTION AND ÆSTHETIC CONSIDERATIONS HAVE NOT BEEN OVERLOOKED IN THE PLANNING OF THE STATION.

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PERSONALITIES IN THE WIRELESS WORLD

COMMANDER B. L. GOTTWALDT

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THE modern capital of Norway, Christiania, was the place of birth of Commander B. L. Gottwaldt, who first saw the light there in 1880. At the age of eighteen he entered the Naval Academy of his native country and, after passing through a brilliant career at that establishment, graduated as Sub-Lieutenant three year later. Between the years 1901 and 1904 he attended the Military Academy of the Royal Navy, and subsequently went through courses at the well-known Technical College in Charlottenburg, Berlin. At the latter institution he devoted his activities to specialising in the study of electrical engineering, telephony, and telegraphy (both wired and wireless). An intense interest in radio-telegraphy had been excited in his mind during the course of his service as a Naval Officer aboard Norwegian warships, whereon wireless had been installed for experimental purposes during the early years of the present century. It was in consequence of the enthusiasm thus awakened that he devoted much attention to the science of ether waves. In the course of 1906 Lieut. Gottwaldt was despatched to England on behalf of the Norwegian Admiralty, in order to co-operate in some special work with Messrs. Armstrong, Whitworth & Co., Newcastle-on-Tyne. Upon his return to his native land he was allotted the task of controlling wireless telegraphy in the Royal Norwegian Navy, a position which he has filled with much distinction ever since. Gazetted as Commander in 1912, he has on a number of occasions been entrusted with the control and testing of wireless apparatus ordered in England and in Germany by the Norwegian Navy. He represented his motherland as one of her delegates at the International Radio Conference held in London in July, 1912.

Towards the close of 1918 Commander Gottwaldt received permission from his official chiefs to take part in the newly instituted Norwegian Wireless Company, " The Norsk Marconi Kompani," of Christiania. He is acting as the Technical Manager of this firm, which is destined to play a most important part in the development of wireless in Norway, especially in the direction of manufacturing wireless apparatus, based upon the Marconi system. He has been a considerable contributor to technical journals on his special subject, more particularly favouring the *Naval Gazette* in this respect. He is, moreover, the author of three separate volumes treating of wireless.

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Super-Sensitive Receivers

Some War-Time Developments Revealed

THE series of articles on valves and valve circuits which has been running practically continuously in this magazine for many months has enabled our readers to realise to some extent the enormous developments which have lately taken place in the art of receiving wireless signals. Until now the heavy hand of censorship has been laid upon our magazine to an extent which only those in intimate contact with the subject can realise, and as a consequence, while we have been able to publish much useful information of a theoretical nature, the actual instruments which have been evolved have remained hidden from the public view.

This month we are able to publish the first photographs of two receivers evolved by the Marconi Company during the war and used extensively in practically every phase of wireless working. They are known respectively as Types 50 and 55. Type 50 is a four-valve fixed-wavelength amplifier and detector. It is used in conjunction with the usual tuners and may be substituted for the crystal detector. It consists, as will be seen from the photograph, of a teak box containing an ebonite panel on which are mounted four small valves, a series resistance and a potentiometer. The valves are of two types, the first three (from the left) being used for high-frequency amplification and the fourth (on the right) as a detector and rectifier. The valves for high-frequency amplification are of a type known as

MARCONI VALVE AMPLIFIER AND DETECTOR, TYPE 50.

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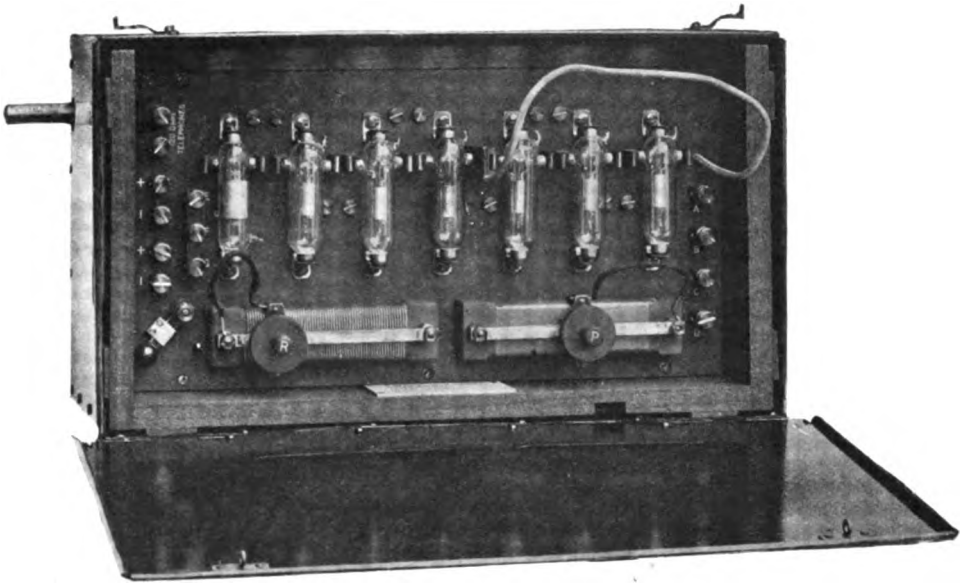

MARCONI VALVE AMPLIFIER AND DETECTOR, TYPE 55.

" V.24 " and differ somewhat in construction from the " Q " type valve used as the detector. In a future article we shall deal in detail with these two types of valve, but for the moment we may say that the plates and grids are differently constructed.

The series resistance inside the box controls the brilliancy of the filaments in the amplifying valves, while the potentiometer is connected to the three grid circuits. On top of the box are mounted a series resistance and potentiometer for controlling the " Q " type or rectifying valve.

It will come as news to many of our readers who are under the impression that highly sensitive valve receivers use very high voltage batteries to learn that in these modern receivers the high tension battery in the plate circuit is of only 24 volts. This battery is connected to the positive and negative terminals on the right hand side of the detecting valve. 60 ohm telephones are connected to the pair of terminals just below. On the left hand side of the box four other terminals will be seen, the upper two being connected to the tuner and the lower to the six-volt battery for lighting the filament. The switch seen on the outside of the case serves to switch the batteries on and off.

The particular receiver illustrated in our photograph is wound for a wavelength of 600 metres, this being the wavelength on which it is most sensitive. It may, however, be wound for other wavelengths. Whilst its construction is such that a 600 metre wave gives the best results, wavelengths not greatly differing from this figure may be received almost equally well, but too great a deviation from this figure brings about a considerable reduction in sensitiveness. The reasons for this, together with many other interesting facts on this and similar receivers, will be dealt with in a further article at a later date.

The practical wireless man will immediately be struck by the extreme simplicity of this piece of apparatus, which is designed to contain a minimum of adjustments. Beyond an occasional adjustment of the series resistance and potentiometers so as to obtain the maximum sensitiveness, this device requires no attention whatever. In this it is in marked contrast with earlier amplifying receivers containing several adjustments for different magnifications and delicately tuned resonant connections between each circuit.

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Another amplifying and detecting device designed particularly to fill the need for a robust and highly sensitive amplifier and detector adaptable without change to a wide range of wavelengths is that depicted in our second photograph. This instrument, which, as will be seen, contains seven valves, is of different construction internally, but is marked by the same main characteristics and ease of adjustment. In this case the first six valves from the right are of the "V.24" type mentioned above, the seventh being a "Q" type valve used for rectifying and detecting. The series resistance and potentiometer shown below the valves are used as before. The two upper terminals on the right hand side of the panel are connected to the tuner, while the three pairs of terminals on the right hand side are connected to the telephones (120 ohm), a 50-volt high tension battery and a six-volt filament battery respectively. It should be mentioned here that although a 50-volt battery is used the voltage impressed upon the plate circuit is no higher than that used in the type 50 receiver already described, the reason for the higher voltage being the higher resistance of certain windings used.

This seven-valve type is shown mounted in a black enamelled box which acts as a screening device. The two slits in the lid of the box enable the resistance and potentiometer to be altered while the box is closed.

Some idea of the super-sensitive character of these receivers may be judged from the fact that connected to a coil of a few turns of insulated wire wound on a former a couple of feet square and without any aerial or earth connection they are able to yield loud signals from ordinary ship installations 200 or 300 miles away. In addition, the signals yielded by the last valve may be magnified still further on a note-magnifying device similar to that referred to in THE WIRELESS WORLD for July, page 224; or, again, two of these amplifiers may be used in series by disconnecting the first detecting "Q" valve and thus placing six or twelve high-frequency amplifying valves in series with a detecting valve.

To Our Readers

Editorial Announcement concerning the New Volume

OUR April issue will start the seventh annual volume of THE WIRELESS WORLD, and the new conditions brought about by the cessation of hostilities will enable us to make a number of important improvements.

Amongst other innovations will be found a series of articles dealing with wireless in its connection with aviation, while a new series of instructional articles will make their first appearance.

Simultaneously we shall *reduce the price of our magazine to NINEPENCE*, thus redeeming our promise to withdraw the higher price at the earliest possible moment. In this reduction we believe we may claim priority over all other magazines. We shall make further reductions just as soon as opportunity offers, and it is perfectly obvious that readers can be of material assistance in hastening this much desired consummation by continuing their support and assisting us to extend the circulation of the magazine.

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Digest of Wireless Literature

"Effects of Dielectric on the Sparking Voltage."*

It is a well-known fact that the usual arrangement employed for the precipitation of fumes or gases consists of a comparatively thin wire placed inside a large pipe along its axis. The wire is maintained at a high negative potential, while the pipe is grounded. When the gases are passed through the pipe the dust contained in them gets repelled from the wire and covers the inner walls of the pipe.

It has been noticed that, in the case of non-conducting fumes, the efficiency of the plant fell off as soon as a sufficient layer of dust was deposited on the collecting electrode. The initial efficiency could be restored by moistening the deposit.

In order to ascertain the nature of the above phenomena, the author carried out a series of experiments, a short account of which is given below.

Instead of a wire and a pipe, a point and a grounded plate, of dimensions sufficiently large to prevent arcing to its edge, were employed. The potential was in each case raised gradually until a discharge occurred. The corresponding voltage was measured by a sphere-gap meter, introduced in parallel to point and plate.

First of all, the influence of the polarity of the point was studied. It was found that with the point negative the arcing voltage was about 2½ times larger than the one observed when the point was made positive. This property was utilised by the author for constructing a H.T. A.C. rectifier.

In the next place, various dielectrics were placed on the grounded plate. When the point was maintained at a negative potential the following arcing voltages were observed :—

No dielectric on the plate	120 K.V.
Mica on the plate	50 ,,
Sulphur on the plate	50 ,,
Glass wool on the plate	50 ,,
Filter paper on the plate	90 ,,
Varnished cambric on the plate	70 ,,
Asbestos on the plate	100 ,,
Edge of glass plate underneath the point	65 ,,
Writing paper on the plate	118 ,,
Writing paper crumpled	90 ,,

It will be seen that the voltage depends not only on the substance of the dielectric, but also on the state of its surface. This is brought out very clearly in the last two cases.

The same effect could be obtained by providing the sheet of paper with a hole, instead of crumpling it.

Another series of experiments have shown that when means were provided for conducting away the charge of the dielectric (by moistening in the case of sulphur, or by covering with a grounded metallic screen in the case of mica), no lowering of

* By E. R. Wolcott, *Physical Review*, Second Series, Vol. xii., p. 284 (October, 1918).

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the arcing voltage could be observed. This seems to indicate that the effect is due to a charge accumulated in the dielectric. The existence of such a charge could be demonstrated by long sparks obtained from the mica, after removing it from the plate or while on it.

From the experiments described above, the author arrives at the following explanation, which we can do no better than quote in his own words: "From these data it appears that a dielectric placed on the grounded plate of a point-to-plate unidirectional discharger, the point being negative, accumulates a charge, the potential of which may be sufficient to ionise the surrounding gas, producing a glow typical of the positive discharge. This glow, being a much better conductor of electricity than other portions of the gas, decreases the total resistance between the two electrodes and lowers the voltage necessary to produce a disruptive discharge."

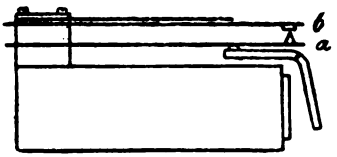
In conclusion, the author draws attention again to the importance of the dielectric having a more or less discontinuous surface. This discontinuity can be effected by roughening the surface, provided the sheet of dielectric is thin enough to be punctured by the discharge.

ON CONTACTS.*

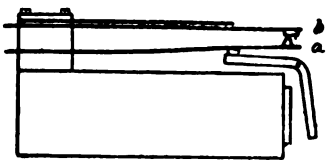
The troubles one experiences in employing relays arise mainly in connection with the contacts. The causes of bad contacts can be divided into three classes:

1. Dirt or dust accumulating on the contacts.
2. The burning away of the contacts.
3. The sticking together of the contacts.

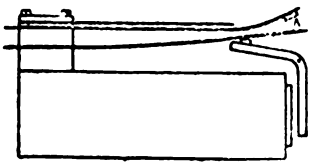
As to the first cause, it can be removed by frequent cleaning and also by making the lower contact in the form of a sharp cone (see Fig.). The second cause involves the elimination of sparking. This can be done, if all conditions (*i.e.*, current, voltage and number of breaks) remain constant, by introducing in shunt to the spark gap, judiciously chosen capacities and resistances. Under variable conditions, however, the contacts will gradually burn away and one must carefully watch them.



A. RELAY AT REST.



B. CONTACTS TOUCH EACH OTHER.



C. ARMATURE FULLY ATTRACTED.

As to the sticking of the contacts, this arises in the following manner: Owing to the spark, which occurs at the moment of breaking, a very fine point is formed on one of the contacts. When the contacts next come together again, a great quantity of heat is developed at the sharp point, and welding takes place. There is not any certain method for removing radically this source of trouble. It can, however, be considerably reduced by arranging the contacts in such a way that one of them should scrape the surface of the other during the period of closure. Such an arrangement is shown on the figure, which does not want any further explanations.

The author gives next an account of his attempts to substitute the generally employed platinum by some other material. Extensive experiments with tungsten gave very satisfactory results. The author introduced tungsten contacts

* "Neurungen an Kontakten und Kontaktmaterial." By H. Fleischbein, *Elektrotechnische Zeitschrift*, No. 45, p. 415 (November 7th, 1918).

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on relays which had to work all day, and where a high degree of reliability was required. The current flowing through the contacts varied from ·5 to 10 amps. The number of interruptions was up to 20 per second. After six months' working no traces of oxydising could be detected.

At first some difficulties were experienced in the welding on of the tungsten. Later on, however, a method was devised (point-to-point welding by means of an arc in an atmosphere of hydrogen) which set the manufacture on a quite commercial basis. The author thinks that, even after the war, when there will be no special difficulty in getting platinum, tungsten will yet be retained as a material for contacts, owing to its advantages in many respects.

"A New Standard of Current and Potential."*

The author describes a new and simple apparatus, which is intended to replace the standard cells in certain classes of measurements.

The idea of the new standard can be seen from Fig. 1, in which the resistances *A*, *C* and *D* form three arms of an ordinary Wheatstone bridge. The fourth arm, *B*, is formed by a platinum wire (about ·005 mm. in diameter and from 1 to 3 cms. in length) placed in an evacuated vessel (the pressure being from 10^{-4} to 10^{-5} mm. of mercury). Now, the resistance of our wire will depend on its temperature, or, in other words, on the current passing through it. It follows, therefore, that the galvanometer will give a zero reading only for a quite definite value of the current flowing through the filament. Assuming, for instance, that resistances *C* and *D* are equal, we must also have resistances of *B* and *A* equal, and this will occur only for one single value of the current passing through *B*, as can be seen from Fig. 2, where the relations involved are represented graphically.

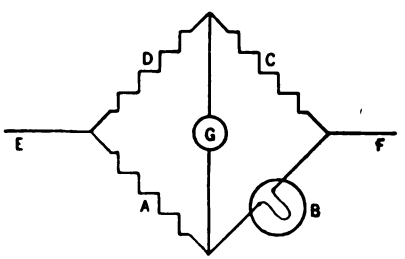

FIG. 1.

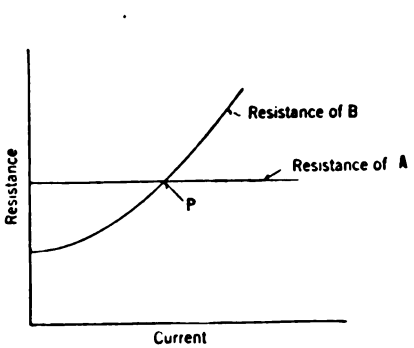

FIG. 2.

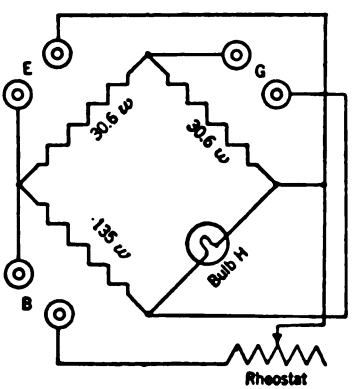

FIG. 3.

It is evident that with a resistance of this type the question of constancy over a long period is of very great importance. This was successfully attained by subjecting the filament to an "ageing process," which consisted in passing through the filament a current sufficient to heat it to a bright red glow, for 24 hours.

* By C. T. Allcutt, *Proceedings of the Institution of Electrical Engineers*, Vol. xxxvii., p. 83.

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Tests made with an "aged" filament have shown that the functional relation between its resistance and the current remains constant. The change in resistance due to evaporation is perfectly negligible if the filament is operated below red heat.

As to the influence of external temperature, it has been found that variations, which may be expected under ordinary circumstances, affect the resistance of the filament in a very small degree indeed.

Fig. 3 gives the diagram of connections taken from an actually built device, a view of which is shown in Fig. 4. The terminals *B* are connected to a dry cell, while the galvo is introduced between the terminals *G*. When the rheostat has been adjusted until the galvanometer gives no deflection there will be one volt between the terminals *E*.

The author states in conclusion that the standard "may be relied upon to maintain an accuracy of ·1 per cent."

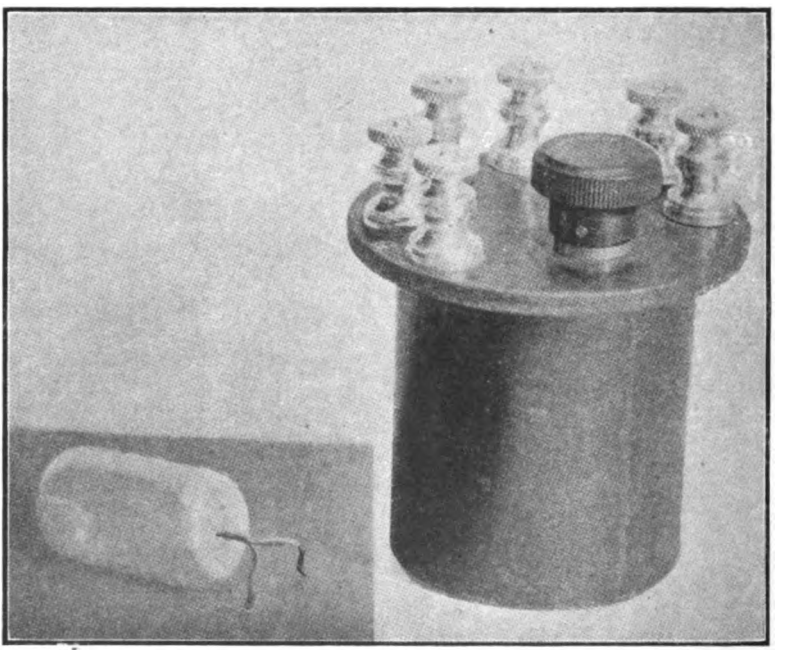

FIG. 4.

FREQUENCY CONTROL

IN an article published in the November issue of *The General Electric Review*, entitled "Better Frequency Control," Mr. Henry E. Warren discusses the Warren method, for which he claims many advantages.

In cases where it is necessary to maintain the frequency of an alternating current system at a definite value, the method hitherto adopted has been that of employing a frequency meter, the readings of which must be constantly noted by an attendant, who makes the necessary adjustment as the frequency due to changes of load deviates from the normal.

Frequency meters indicate instantaneous values, and hence it often happens that before the operator has time to readjust the machine to changed conditions, which incidentally may be momentary, another adjustment becomes necessary.

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With the new method frequent and often unnecessary adjustments are avoided, the device described indicating the average value of the frequency. In this way it is only necessary for the operator to make adjustments at such times as the average value alters.

A short survey is made of the disadvantages and errors introduced by the use of indicating frequency meters, amongst which are enumerated: (1) the errors introduced by adjustments made from momentary observations and the necessity for frequent attention on the part of the operator in order to ensure tolerably accurate results from this method; (2) errors of significant value introduced through the calibration, the effect of time, depreciation and changes of temperature; the departures from the average frequency are estimated by Mr. Warren to be as high as one and two per cent. at large power stations using the frequency meter method of control; (3) errors due to the difficulty experienced in taking precise readings and the limited size of the scale graduations.

In general the new method conveniently and accurately compares the number of completed alternations with elapsed time, being practically insensitive to the instantaneous value.

The instrument itself consists of a complete pendulum clock with two dials, the lower dial serving the usual purpose of recording the time of day, whilst the upper dial, which is of larger diameter, has two hands, one black and the other gold-coloured. The black hand is revolved once in five minutes by the clock mechanism, whilst the gold-coloured hand is independently revolved through gearing by a small self-starting synchronous motor supplied by a transformer from the alternating current system. The gearing between the gold hand and its motor must be such that at the normal frequency of the A.C. system, on which it is operated, the gold hand is revolved at the same speed as the black hand. Special features of the clock mechanism are novel regulating arrangements and absence of error due to changes of temperature.

In order to operate this instrument the black and gold hands are set over one another, and the operator is instructed to correct the speed of the turbines if the gold hand gains or loses with respect to the black hand.

Inasmuch as this system only responds to sustained changes in frequency, adjustments are made by the operator, only at such times as a change in the average value is indicated by the device. Thus much labour is saved, and by its simplicity of construction instrumental errors are reduced.

Sketching past performances of this instrument, the author states that it has been in constant operation for 24 hours per day at the works of the Boston Edison Company without repairs of any kind since October, 1916, and he calculates that the improvement in their frequency regulation is such that no change in frequency can be shown when readings taken with the Warren method are plotted on the same scale as readings taken with the frequency meter method.

Mercantile Marine Uniforms

THE Board of Trade have made arrangements with the Admiralty for the inclusion of uniforms for officers of the Mercantile Marine in the Admiralty scheme of control for the provision of naval officers' uniforms. Tailors and outfitters on the Admiralty list will be notified by the Admiralty that Mercantile Marine officers' uniforms may be made from the P.N. cloths at the prices already arranged for naval officers' uniforms which are made from P.N. cloths. Tailors and outfitters who have regularly made Mercantile Marine officers' uniforms in the past, but who are not already on the Admiralty list and who desire to be included, should make application to the Director of Contracts, Admiralty, London, S.W.1, direct.

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Submarines and their Wireless

Some Personal Experiences of a Radio Engineer

By S. C. ANSELMI

(Continued from page 553 of our January issue.)

DURING hostilities, in order to avoid the danger of being attacked by Allied vessels, the Spanish Government painted their submarines a bright white colour, encircling the conning towers with bands of red and yellow, the national colours of Spain. This precaution deprived their vessels of much of their warlike appearance. When the submarines went out for a short cruise or diving practice, they were escorted by a surface vessel. The wisdom of this precaution will be seen from the following incident. One day the crew of A2 returned to Cartagena in a state of high excitement, and the town was speedily filled with wild rumours of an attack having been made on this Spanish submarine by a cargo boat. What actually occurred I learned from one of the officers. It appears that on the way back from a bay frequently used for diving practice, just as they doubled one of the small promontories which abound on this coast, they came within the close proximity of an 8,000-ton Italian steamer seeking the protection afforded by Spanish territorial waters. The Italian, believing the Spanish craft to be a Hun in disguise, and knowing the little regard these pirates pay to International Law, immediately trained their big gun upon the vessel, and would have opened fire had not the escorting torpedo-boat come in sight with the Spanish flag waving from its after-mast.

VIEW OF DECK AND CONNING TOWER LOOKING FORWARD. THE TELEPHONIC BUOY APPEARS IN THE FOREGROUND.

An interesting life-saving appliance is carried on each of the craft. This consists of a buoy placed on deck, the interior of which is fitted with a telephone transmitter and receiver. The position in which the buoy is fixed will be seen, from the accompanying illustration, to be close at the foot of the conning tower. Should any accident happen, so that the submarine could not rise from the watery depths, this buoy can be released, and any ship that came along could read the following appeal imprinted on a large brass plate carried on the cover of the float :

ATTENTION—TELEPHONIC BUOY—SUBMARINE . . .
—DO NOT FIRE AT BUOY : OPEN THE LID—
FOLLOW INSTRUCTIONS ENCLOSED.

Two additional buoys are placed at each extremity of the vessel. These, which are capable of being released from the inside, carry a hemp rope, many fathoms long, reeved through two large lifting-eyes fixed on the boat's deck. They are intended for the use (in case of disaster) of a submarine salvage ship, which would reeve a strong steel chain through the lifting-eye of the submarine by means of these two hemp ropes. In addition to these devices the keel of the submarine, which weighs about nine tons, may be released, in order to assist the vessel to rise.

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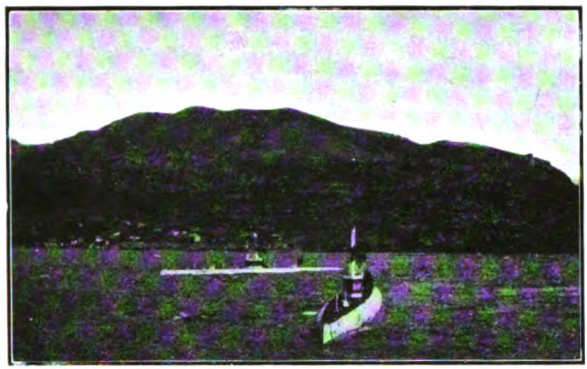


A2 AND A3 AT ANCHOR IN THE BAY OF MAZARRON.

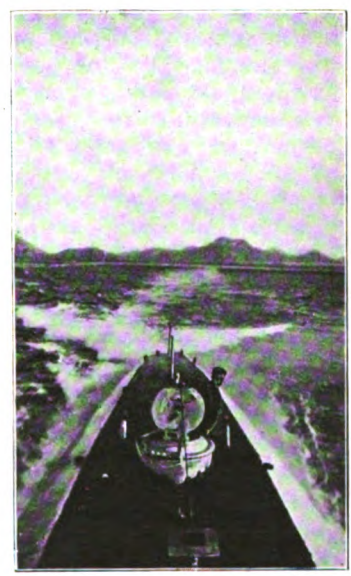
Perhaps the readiest way of giving readers an idea of what conditions on submarines are like would be by asking them to accompany me on a short cruise in one of them. . . .

We reach their mooring place in the Cartagena arsenal (see illustration on page 609) at 7 o'clock in the morning; and an hour later the A2 and A3 lift their anchors and glide majestically out to sea. Our first impression is that we are being carried, like Sindbad the Sailor of "Arabian Nights" fame, upon the back of a vast fish. 'Tis a brisk, sunny November day, such as one meets only in the Mediterranean Sea. It does not take us very long to glide past our escort, the gunboat *Bonifaz*, and we notice that she seems to labour in the choppy sea, through which we are gliding with ease.

The wash of the water churned by the propellers heightens the fish-like aspect of the vessel as we gaze aft from the windows of the conning tower. Our picture (see below) gives a very fair idea of the view obtained, and the officer who steps on deck from the half-open hatchway smiles with subconscious appreciation of the conditions in which we find ourselves.

After three hours of delightful voyaging, at the rate of twelve knots, we reach the Bay of Mazarron, where we stop and prepare to submerge. We watch our crews as they trim the decks of movable gear and disappear with them down the hatchways. As soon as the latter are screwed up, so as to be watertight, our engineers start the electric motors and the boat slips quietly along with its human load inside it. The temperature within our steel envelope is fairly high, and we are glad to dispense with as many garments as decency will permit. Portholes in the conning tower afford an opportunity of witnessing the actual diving operation, and it is there accordingly that we take our stand. An order comes that the water-tanks are to be filled. Little by little the hull disappears below the surface, and waves start breaking against the glass windows of the conning tower right in our faces. What are our sensations under such circumstances? For my own part, I feel no tremor; the outstanding impression is a sense of awe in face of the immensity of the watery waste surrounding the boat. The last words I utter as we disappear beneath the surface are "Great Scott! What a lot of water!"

Now we are fairly underneath, and become immediately struck by the cessation of perceptible motion and by the deadening of sound. A quiet hush reigns throughout the vessel, broken only by the hum of the big motors and by the spoken orders of our chief. Nothing meets our view, as we peer out of the conning-tower portholes, save a luminous film of green water. The popular belief that fishes can



VIEW OF SUBMARINE ON THE SURFACE LOOKING AFT FROM THE CONNING TOWER.

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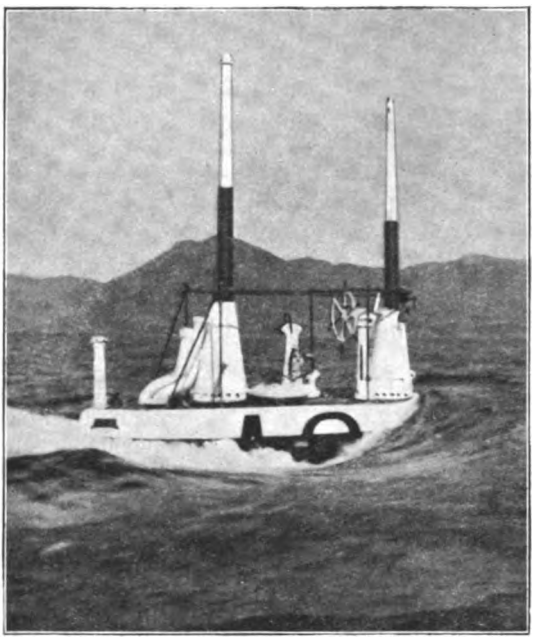

THE A3 RUNNING AWASH. THE DARK PART OF THE PERISCOPE IS TELESCOPIC.

be seen gliding past the windows under such circumstances is erroneous, and probably arises from the widespread perusal of that fascinating scientific prophecy of Jules Verne's *Twenty Thousand Leagues Under the Sea*. As a matter of fact, all denizens of the deep are frightened away from the vessel's neighbourhood by the motion of the propellers.

Have you had enough of the conning tower? Well, let us go down to the navigating room. Here we find everybody at his post. One of the periscopes is in charge of the commander, whilst a subordinate is scanning the neighbourhood through the submarine's second "eye." Let us ask leave to take a peep ourselves. The moment I get the opportunity and apply my eye to the instrument, I am struck by the great range of vision obtainable. Every object seems perfectly clear; the only drawback is that one is apt to gain a false impression as to the distances separating us from objects on the surface. Yonder, about 200 yards away on the port side, I can just discern the periscopes of our sister craft. As I peep the vision disappears, and I notice that the poise of our ship has altered. We are descending at an angle. We plunge down to a depth of 18 to 35 feet, and I begin to feel some slight anxiety as to the possibility of a collision of the two submarines operating so close to each other. Both are by this time "in the dark." Suddenly we hear the strong, beautiful note of the Fessenden oscillator as it sends a call to the A2. This seems to have the same calming influence upon our nerves as the wireless spark must have upon passengers on a liner when they believe themselves in peril. The two boats now maintain a continuous subaqueous communication. The messages sent from our sister ship can be clearly heard by all on board as the sound-waves strike our hull. All the time the operator is receiving I notice that he keeps changing

RISING TO THE SURFACE ON A SLOPING KEEL. A RATHER DARING FEAT.

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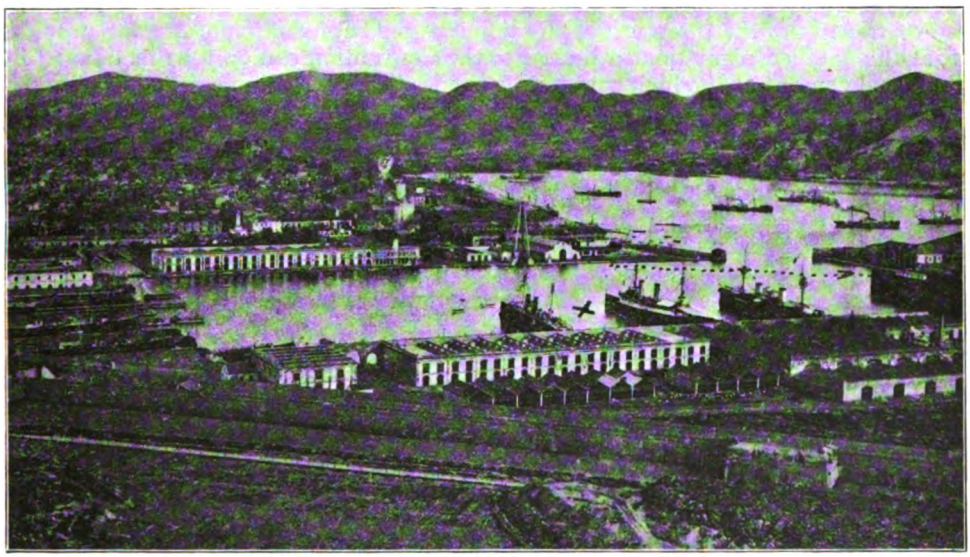
his telephones from one side to the other. This enables him to advise the commander whether the A2 is on the port or starboard side. Despite the fact that we have been under water for nearly two hours, I do not notice any sense of stuffiness and no trace of buzzing in the ears. The atmosphere appears quite normal, and I observe a point of difference between the British and Spanish submarines in the matter of testing the salubrity of the air. The former carry canaries; the latter pin their faith upon white mice! Canaries are supposed to be specially sensitive to any vitiation of the atmosphere. Soon after 2 p.m. we rise to the surface again and anchor the boat. Now all on board the *Bonifaz* for a frugal and well-earned meal! This afternoon we spend in evolutions awash, and start for home at 5 o'clock in the evening. (*Concluded.*)



THE NAVAL DOCKYARD AT CARTAGENA. THE POINT AT WHICH THE SUBMARINES USUALLY LIE IS MARKED BY A CROSS.

International Wireless Administration

Some Suggestions asked for by the Berne Bureau

IN the issue of THE WIRELESS WORLD for August last, under the heading of "A Striking Sign of Rapid Expansion," we detailed the suggestions made by various nationalities, in response to a request of the Berne Bureau, with the view of meeting certain difficulties which are likely to arise ere long in the allocation of station call letters. The rival suggestions were three in number.

We have received circular No. 101, issued by the International Radiotelegraphic Bureau at Berne on November 30th, which sums up the situation as it stands at present. The preceding circular No. 98 had set forth the rival solutions proposed:—

(*a*) That of the British, which suggested that after the combinations on the present three-letter system are exhausted, each administration shall be able to use signs of four letters formed by the letter T followed by one of the three-letter combinations at present reserved for its use.

(*b*) The German proposal, which is based on the same principle, but advocating the insertion of the letter T at the end, instead of at the beginning, of the four-letter groups.

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(c) The Dutch suggestion, which followed on the lines of the British, but substituted the letter P instead of the letter T as the initial sign of the four-letter combination.

In the second Berne circular above referred to (No. 98 of June 18th last) the administrators asked that the nations who are members of the Convention should reply before November 20th, 1918, stating which proposal met with their approval. The circular which we are at present considering (No. 101 of November 30th) states that out of the 71 nationalities who adhere to the Convention, only 15 replied before the expiration of the time limit. Out of these, nine voted for the British proposal and four for the German; whilst the Netherlands remained in their minority of one. The fifteenth reply came from Mexico, which sided in principle with the Netherlands suggestion, varying it, however, by desiring that the letter P should be placed at the end.

Article 11 of the International Radiotelegraphic Convention of London provides that the detailed regulations attached to the Convention can only be modified "by "mutual consent of the high contracting parties." Under the present circumstances, "mutual consent" has not been arrived at, and all the proposals are, therefore, taken as rejected in accordance with the provisions of paragraph 9 of Article LXXXIV of the Telegraph Regulations.

The German Administration gave as its reason for adherence to its own counter proposal that "with regard to the four-letter combination with either P or T, one "must always reckon on the possibility of error in reception, if the signals be not "transmitted in accordance with strict telegraphic rule. There is the special "objection to the use of P that the telegraphic transmission would be thereby "unnecessarily prolonged."

The Belgian Administration, in supporting the British proposal, considered that the objection raised on the score of faulty signals would speedily cease to apply in practice, especially in view of the fact that calls are always repeated three times.

A reply from British India was received after the time limit, but the Berne authorities think it worth while to quote their views. Briefly, they amount to agreement with the Netherlands suggestion of P instead of T; but propose that it should be placed as the third or fourth letter of the combination.

A still more recent circular, No. 102 of December 5th, 1918, states that the U.S.A. have submitted a fresh proposal, on which the International Radiotelegraphic Bureau at Berne ask for the votes of the parties to the Convention. This proposal is that, after the three-letter combinations have been exhausted, a four-letter series shall be used as supplementary thereto; and that these four-letter combinations shall be arrived at by doubling the first letter of those three-letter combinations of the original system which have been allotted to the various countries. Thus, the whole of the triple combinations beginning with N, from NAA to NZZ (which are allotted to the U.S.A.), might be supplemented by a series of four-letter combinations beginning with a second N, from NNAA to NNZZ.

French Somaliland

WE are informed, through the medium of a Berne circular, that the necessary overtures have been made by the Minister for the French Colonies for the adhesion of the French Coast of Somaliland to the International Radiotelegraphic Convention. The new station at Djibouti on this coast was recently notified as ready for service.

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A Tribute to Wireless and Wireless Men

Some Gratifying Words of Praise for Radiotelegraphy and Telegraphists from our Leaders in the War

In the summer of 1914 Senatore Marconi uttered the prophetic words: "The "value of wireless telegraphy may one day be put to a great practical and critical "test; then perhaps there will be a true appreciation of the magnitude of our work." Within a very brief space after his utterance the test arrived. After a period of trial extending over four years and three months, the results attained have more than justified the most sanguine expectations. The tests have been searching in the extreme, and have affected every branch of the active services—at sea, ashore, and in the air. We are able here to reproduce, from the chiefs of the various branches of His Majesty's Service affected, their autographed verdicts on the result of the practical and critical test to which Senatore Marconi referred. These form at the same time eloquent testimonials to the gallantry and devotion of the men who have carried them through. The period of trial started on July 30th, 1914, when the First Fleet, which had just left Portland after the great Naval Review at Spithead, was recalled by wireless telegraphy, and instructed not to disperse for manœuvre leave, as had been previously arranged. Ever since that date the aerials over the roofs of the Admiralty, which Horatio Nelson's statue overlooks from its lofty perch in Trafalgar Square, have been busy night and day picking up messages from the Grand Fleet, and from all quarters of the globe; transmitting information and issuing orders. There has never been a moment when the ether was free from messages transmitted by the ships themselves. The science fulfilled its destiny in completely revolutionising naval warfare; whilst radiotelegraphists have played as important a part in the maintenance and accentuation of British sea supremacy as their gallant confrères aloft, at the guns, or in the engine room.

It may be not inapposite to recall the impressionist sketch of an American correspondent who visited the Grand Fleet during the autumn of 1915. Our friend from overseas was conducted through the flagship and finally into the little cabin which forms the "hub" of the mighty organisation:

"Stepping into a small room where telegraph keys clicked and a compact wireless "apparatus was hidden behind armour, we saw one focus of communication which "brings the Admiral word of any submarine sighted, or of any movement in all the "seas around the British Isles, and carries the Commander-in-Chief's orders far and "near. The complicated manœuvres of a modern fleet are only possible under such "conditions. The 'traffic,' as it is technically called at headquarters, is enormous. "The lieutenant-commander in charge of signals has information poured over him "without cessation; sheaves of white forms intrude upon his plate as he sits at "table, are thrust into his hand as he goes on deck, follow him wherever he is in the "ship, and fill his cabin. Only the Admiral and the paymaster who acts as the "Admiral's secretary can guess the vast mass of detailed information, instructions "and routine, connected with the squadron wherewith they daily wrestle, even when "the enemy makes no attempt to bring them to action. 'Stupendous' is the only "word which can adequately describe the paper work alone. This goes on without "cessation; the British Fleet is on active service all the time."

Such is the test through which wireless telegraphy and its exponents have issued triumphant. Comment is needless—Admiral Sir David Beatty's letter, written with his own hand, and here reproduced in facsimile, tells its own tale.

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15. 12. 18

Sir

Your original letter certainly failed to reach me as I should have answered it before this.

I am very glad to be able to testify to the very excellent and efficient Service performed by the Wireless Ratings of His Majesty's Navy. On the efficient working of the W/T installations, and the accuracy of the Operators, depends largely, the Control of the Large Fleet of Vessels which Constitute the Grand Fleet. They have maintained W/T touch at all times, whether Steaming in Action. when Operating in Gales. and have welcomed all

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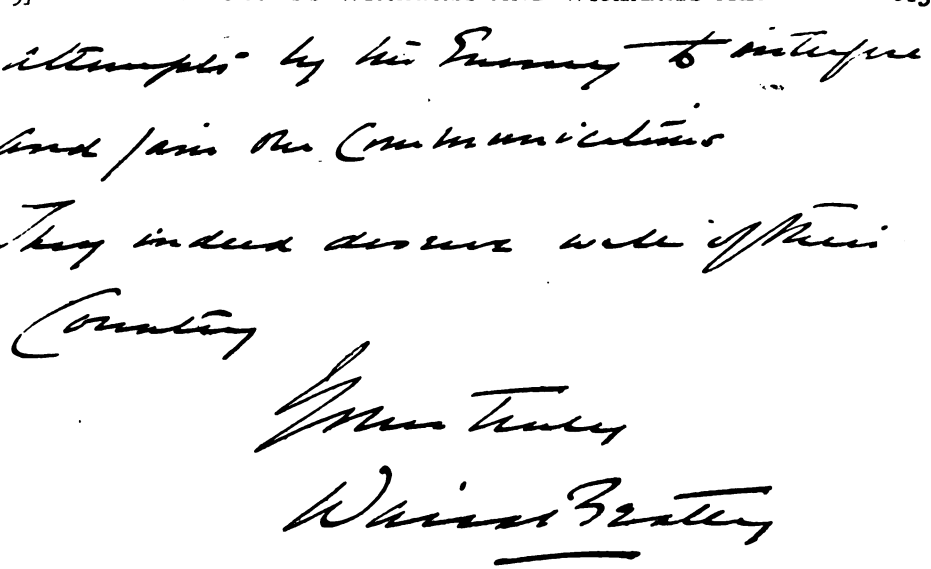

Can any service receive words of higher commendation from its chief? Sir David Beatty informs us that naval operators have "maintained W/T touch at all "times, when shot away in action, and blown away in gales." He summarises the situation by stating that "they indeed deserve well of their country."

We feel certain that every individual in the wireless ratings of His Majesty's Navy will treasure such praise to his life's end. The gallant Admiral's additional remark that they have "overcome all attempts by the enemy to interfere and jam "communications" constitutes an interesting authoritative announcement on the question of interference which attracted so much attention in pre-war days. WIRELESS WORLD readers will doubtless find thereby recalled to their recollection the abortive efforts of the enemy to jam during the fight between Admiral Sturdee and Von Spee on December 8th, 1914, when "pandemonium reigned in the ether." *

* * * * * *

Ashore, wireless telegraphy introduced almost as complete a revolution into military communications as it did afloat. The area over which guns range is now calculated in miles, and the whole field of operations has been immensely magnified. The lay reader may perhaps not realise what it means to depend for inter-communication upon miles of wire which may be severed at any point and at any moment; but any military leader would understand in a moment what his indebtedness is to a system which eliminates these risks. The important part played in the Great War has been shared by wireless installations of every description, from the quasi-permanent equipment of Headquarters to the motor-van and pack sets which accompany the front lines when they move. As for military aircraft, it is impossible to overestimate their services, not only in "spotting" for the artillery and in actual fighting work, but in that most important work of observation which more than anything else earned for them the title of "the cavalry of the air." The recently issued despatch of General Allenby attributed his success in Palestine largely to the fact that the Royal Air Force achieved supremacy over the enemy, preventing him from receiving intelligence and keeping up a continual stream of information to British Headquarters. Such communication work is, under modern conditions, almost entirely carried out by wireless.

The letter from Field-Marshal Sir Douglas Haig, which we reproduce here, sums up in a few terse words his appreciation of the valuable services which have

* See "The Falkland Islands Naval Engagement," which appeared on pages 766–8 of our issue for March, 1915.

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GENERAL HEADQUARTERS,

BRITISH ARMIES IN FRANCE.

1st December, 1918.

The Wireless Press, Limited,
Marconi House,
Strand, LONDON, W.C.2.

I am glad to take the opportunity you offer me to express my very real appreciation of the good services performed by the wireless telegraphists throughout the war. Their work has been one of great and increasing importance, and the zeal and efficiency with which it has been carried out has been of great value to their country.

D. Haig. F.M.

Commander-in-Chief,
British Armies in France.

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been rendered by radiotelegraphists under his command, and his message will be valued as highly by military wireless men as that of Sir David Beatty by those who have served at sea.

* * * * * *

One of the outstanding lessons which we British have learned during the recent conflict consists of the supreme national importance to these islands and to the Empire of all shipping, not only naval but mercantile. Modern warfare has indeed done away with the old division in wartime between civilians and belligerents. Nations threw the whole force of their being into the struggle; and those energies which in peacetime were devoted to carrying the flag of commerce to every sea, focused themselves on beating the arrogant enemy, who not only challenged, but affected to despise them. The struggle has brought out in a dramatic fashion the greatness of Britain's shipping organisations and the gallantry of the men engaged therein. Common danger and common effort have drawn the two great sea services more closely together, and have proved to "landlubbers" that courage and devotion are the characteristics of both.

During the past four years the pages of THE WIRELESS WORLD have chronicled such of the more prominent instances of heroism as the Censor allowed to appear. The duties of a wireless operator on a merchant ship in times of peril are of paramount importance to all on board. It is no small matter of pride to reflect that in no single instance which has reached us have ships' telegraphists failed to rise to the occasion. The submarine menace did but intensify their courage and devotion, as it intensified their danger. Many of them were lads under military age, and it may be not inopportune to record the fact that during the last year of warfare no fewer than seventy wireless operators under the age of eighteen have made the Supreme Sacrifice in the discharge of their duty. Sir Joseph Maclay, the Shipping Controller, has sent to us an autographed message of praise for the way in which they discharged their duty. This message constitutes an official acknowledgment of the work they have done for England, and will be prized as such not only by the living, but by those who mourn their dead.

The wireless telegraph has played a crucial part in the conduct of the war on sea as on land and in the air, and I am glad to have the opportunity of expressing my warmest admiration for the manner in which the wireless operators on board our merchant ships have throughout discharged their very trying and often most dangerous duties. The safety of officers and passengers and crews has time and again been in their hands and they have ever maintained the highest traditions of our sea service.

J. A. Maclay.

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Wireless Horology

The Possible Application of Wireless to the Regulation of Clocks

THE fact that ether waves travel with the speed of light, and are consequently practically instantaneous, as far as distances on our globe are concerned, places wireless telegraphy in a peculiarly favourable position for dealing with time. The principal use up to the present to which this function of wireless has been applied consists of the issue of time signals, which form such familiar features to wireless men all over the world. By these signals thousands of navigators regulate their chronometers in all quarters of the globe, and on their accuracy depends the correct reckoning of many a ship's longitude.

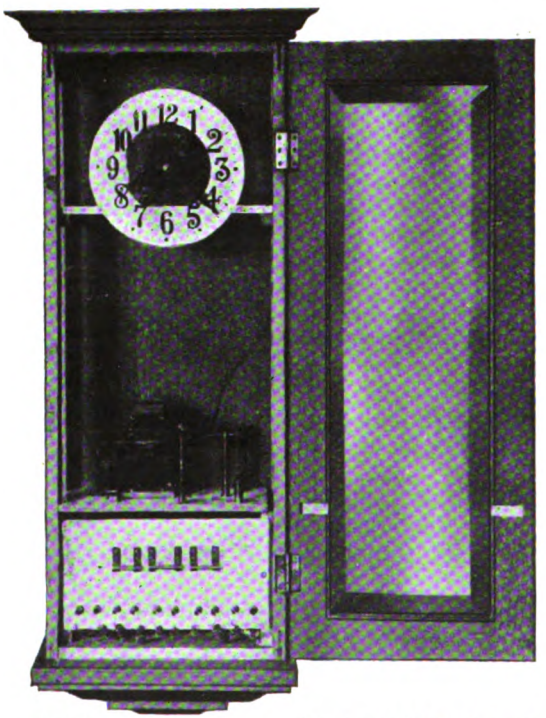

Photo.] [*Underwood & Underwood.*

WIRELESS TIME CLOCK OF GERMAN MANUFACTURE.

The wireless amateurs of our own country, in times when they can be allowed to conduct actual experiments, soon become well acquainted with the time signals radiated daily from the Eiffel Tower, and those of other countries are doubtless on equally "good terms" with the signals sent out from Washington, Melbourne, Chosi, Darien and other radiotelegraphic centres.

In pre-war days the well-known chronological expert, Mr. Alfred E. Ball, conducted a series of experiments to test the possibility of actually regulating clocks automatically by wireless waves. The results were so successful that, in a detailed article from his pen, published in THE WIRELESS WORLD, Vol. III., pages 15–20, Mr. Ball deliberately gave it as his opinion that in the future "one of the most "useful forms in which radiotele- "graphic waves will be pressed into "the service of the horologist will "be the wireless regulation, or rather "supervision, of public clocks." Mr. Ball's experiments, in common with so many others, had to be given up on the outbreak of hostilities; but they are doubtless only in the state of "suspended "animation."

Undoubtedly the possibility of such instantaneous regulation opens out a tempting prospect of doing away with the annoyance of the variation in the times announced by our public instruments, and Mr. Ball's experiments are probably far from being the only ones carried out having for their aim the realisation of this desirable project. The illustration which we print on this page shows a time regulator for wireless telegraphy set up at Fulda, in Germany, and would appear to illustrate an attempt to construct an instrument based on Ferdinand Schneider's system, whereby clock mechanism may be set in motion through the medium of wireless telegraphy.

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Endeavour and Achievement

The Story of a Successful Effort to Cope with National Needs

THE full story of the magnificent work performed by wireless operators in the Mercantile Marine during the Great War still awaits the telling, although numerous individual instances have come to light in this magazine and in the general Press. Nothing, however, has yet appeared recording the really remarkable feat performed by the Marconi organisation in obtaining at short notice, training and sending to sea the young men who have done such good service *pro patria*. It was extremely fortunate from a national point of view that the Company had in peace time carried out the practice of maintaining direct control over their large body of employés on various steamship routes. Their policy has fully justified itself in the light of experience, demonstrating at a time of national crisis that it conduces to the interests of the Empire. It was owing to this policy, and this alone, that it was possible to carry out the stupendous task recorded below.

THE INITIAL EFFORT.

On the outbreak of hostilities in August, 1914, the Marconi Company were maintaining upon their books a regular operating staff of just over 1,000 men, together with but a relatively small number of men in training to fill the gaps caused by normal requirements. This staff was steadily, but gradually, increasing day by day, to meet the needs automatically created by the fitment of additional ships with wireless telegraphy. The declaration of war, however, brought to this Company, as to many others, a number of extremely difficult problems calling for immediate solution.

The Navy forthwith summoned all those men who had previously indicated their willingness to serve in the Royal Naval Reserve should a war break out. The number, however, of those thus available speedily showed itself far from sufficient, and the Company—laying aside its own interests—made an immediate call for volunteers. Seeing that necessarily, under the conditions of their service, boardship operators are dispersed in all parts of the world, comparatively few are on shore at any one time, but determined efforts, combined with a number of personal appeals, achieved the result of obtaining immediate offers of service from the great majority of the men. Thus the wireless operating staff voluntarily deprived itself *ab initio* of a large proportion of the very best operators in the service.

As men came in from their voyaging abroad still more were withdrawn, and ere long several hundred men had proceeded under naval orders to Chatham, Portsmouth, and other centres. These were distributed amongst the various classes of His Majesty's Navy: battleships, dreadnoughts, cruisers, destroyers, armed trawlers, submarines, etc. One of the first naval tragedies of the war—the sinking of the *Hogue*, *Cressy* and *Aboukir*—involved the sacrifice, in each instance, of expert telegraphists thus early supplied by the Marconi organisation.

Meanwhile, with their personnel depleted to a dangerous limit, the Marconi Headquarters Staff in London, setting to work at high pressure, had managed to call up a number of additional men from the waiting list. During every hour of the day and night new applicants were being interviewed, medically examined, tested, and passed to sea. Fortunately, there were a number of young men under tuition as wireless operators in the various schools whose training could be speeded up. By bringing in such students and by drastic reforms in procedure, the main difficulties were tided over for the moment, and the work of supplying operators to merchant ships continued.

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Had matters stopped at this point the war records of the Company would have constituted a worthy subject of pride. But they were continued long past it.

At the end of May, 1917, the Operating Staff had been increased from the 1,000 men in hand three years before to 2,900, whilst some 325 students were attending day and evening classes at Marconi House.

THE CRISIS.

Then, just at a time when the ordinary source of supply of wireless man-power was showing itself scarcely sufficient to meet the requirements of newly fitted ships, when the loan of picked men to the Navy and other specialised services had sorely thinned the ranks of the best men, at a time, moreover, when the pressure of general recruiting was sweeping into the fighting services numbers of youths who might have been suitable for training as wireless operators, and when the Royal Flying Corps, the Royal Naval Volunteer Reserve and the Royal Naval Air Services had added to the difficulties by their own training schemes for wireless men, THE NATION AT LARGE WAS CONFRONTED WITH THE SINISTER MENACE OF THE SUBMARINE, AND THE AID OF WIRELESS WAS INVOKED.

At such a crisis as this, it was realised what radiotelegraphy means to ships under stress of peril at sea. Unfitted vessels were falling like ripe plums into the U-boat basket.

A conference was held at the Admiralty for the purpose of considering the practicability of fitting with wireless telegraphy all ships of 1,600 tons and over. The desirability of carrying two operators for maintaining continuous watch was also emphasised. The authorities thereupon approached the Marconi Company with the view of ascertaining whether they could possibly cope with so huge a task. Few ships under 3,000 tons had up to that date been fitted, and it was quite evident that not only would a tremendously increased volume of wireless apparatus have to be made and supplied, but that the Operating Staff would need to be practically trebled. It was estimated, in other words, that the trained personnel, already increased in three years from 1,000 to nearly 3,000 men, would have to be swelled to a total of about 4,000 to 4,500 *in a few months*. With full knowledge of his gigantic task, Mr. Godfrey Isaacs, on behalf of the Company, undertook definitely to provide both apparatus and men.

As soon as the Marconi Company got to work, a review of the situation made it clear to the management that (1) very special inducements would have to be held out if young men were to be attracted in sufficient numbers for this career, and (2) that the previous age limit would need to be lowered so as to prevent mutual interference between their scheme and the requirements of the military. Up to this time any young man who desired to become a wireless operator had been obliged to pay a fee for his training at one or other of the private wireless schools distributed throughout the country. It is true that some men were receiving gratuitous training at Marconi House, but this number was small compared with the total number of men in the various outside establishments. As part of the new scheme, a course of free tuition was offered, and—the school accommodation at Marconi House itself being insufficient for accommodating the number required—arrangements were made with King's College and with the Birkbeck. Further, in concert with the educational authorities in Birmingham, Leeds, Newcastle and Glasgow, similar schemes were established in those cities.

The wide publicity campaign so well known to most of our readers was then instituted, and ere long suitable candidates presented themselves for a course of intensive training.

GOVERNMENT ACTION.

The Government authorities, seeing that the Marconi Company had their undertaking well in hand, issued on October 23rd, 1917, an Order in Council making

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wireless compulsory on 1,600-ton vessels and upward. The publicity campaign already in full swing was extended by the conclusion of arrangements with the Royal College of Surgeons and St. Bride Foundation. These London institutions undertook the accommodation of additional students to be trained under the direct control of the Company. Furthermore, in order to tap provincial centres to a still larger extent, and to assist those young men who were unable to leave their homes to take up residence in London during tuition in wireless training, additional centres were established in the provinces, the scheme now extending to ten municipal colleges and six private wireless schools. Suitable apparatus of a modern type, together with keys, buzzers, telephones and other accessories, were lent to such institutions as were not already provided therewith. The number of students grew rapidly, until, by the end of April, 1918, no fewer than 2,660 pupils were in training, under 51 instructors provided by the Company and 62 furnished by the schools themselves. An ample supply of students having been thus secured through these special advertising schemes, which included posters, announcements in cinema theatres, newspaper write-ups, and display advertisements, the free training scheme was closed on April 1st, 1918.

The record of the year following September 1st, 1917, constitutes a very remarkable achievement. Nearly 1,000 ships were equipped by the Company with wireless apparatus, whilst between 2,000 and 2,500 operators were trained and supplied to the Mercantile Marine—that is to say, that over this period *every day in the week saw three ships fitted with wireless apparatus and six operators supplied.* The number of vessels carrying only a single operator was reduced by one-third; whilst, at the end of that period, over 1,000 students were still in training under the Marconi's Company's scheme to provide the necessary reserve supply for the newly equipped vessels and for those whose operating staff was increased. The beneficial result of this wonderful piece of work was speedily manifested in the improved position with regard to the safety of the Mercantile Marine; and there can be little doubt that this "Wireless to the Rescue" programme played an important part amongst the British counter-strokes which defeated the enemy's submarine efforts.

The Material Problem.

We have dwelt mainly upon the work accomplished in the enlistment of recruits and their instructional training, because the human element constituted the more difficult of the two problems. But the material side was only second thereto in its formidable character. Every possible means had to be resorted to for increasing the supply of new apparatus. Additional plant was laid down at the Marconi Works in Chelmsford, and the workers engaged there were called upon for intensified effort. Right well did they respond to the appeal; but at the height of the pressure it was found necessary to obtain a certain number of sets from America and Canada, and to impress every available man upon the Engineering Staff for the fitting on shipboard of the new equipment. Valuable assistance in this direction was also rendered by a number of the "old hands" amongst the operating staff.

It will be easily understood that, in the midst of this whirlwind of demands for fresh apparatus and operating staff, the skill of those who had already had the benefit of previous experience was invaluable. Yet, simultaneously with so vastly enhanced a need for their services, the Marconi Company was obliged to part with a large proportion of them. Right from the start of the war heavy drafts of experienced men were detailed for Admiralty service, and even up to the last few days before the signing of the armistice, the Marconi Company was responding to the call for practised experts to take up duty, both in the military and naval branches of His Majesty's Forces. The results of the activities of these men remain, up to the present, practically unknown to the general public. Silence had perforce to be maintained concerning the large staff of skilled wireless operators engaged in

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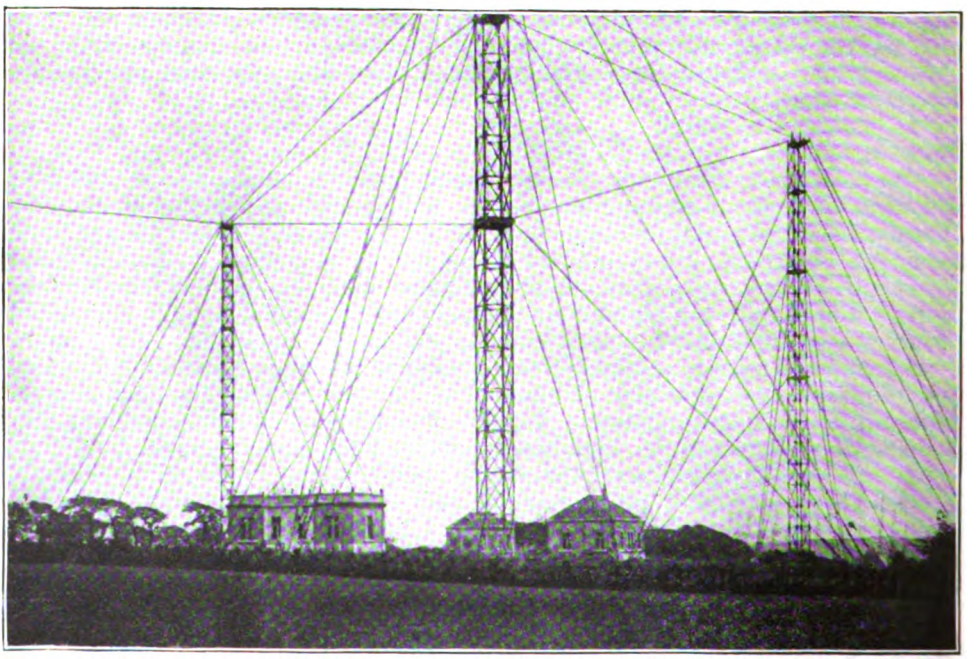
expert work at direction-finding stations distributed all around the coast. It was by their aid that enemy submarines, surface ships, Zeppelins and other aircraft were accurately located. Then, too, a number of men were called upon to proceed to distant quarters of the globe for service in specially erected wireless stations, which have proved of the utmost strategic importance.

We are only able here to refer to these matters in outline; the full story of this and other special branches of wireless work must be reserved for subsequent issues. What we have set before ourselves is the task of throwing some light upon the great achievement involved in thus providing wireless operators and apparatus to safeguard the National Mercantile Marine. Now that hostilities have ceased this feat can be viewed in its true perspective. The wireless service has every reason to be proud of its endeavour and its achievement, although its justifiable pride is sobered by regret for the large number of lives which have been lost in the attainment of this splendid record. On another page we publish a tribute to wireless from the chiefs of the various branches of His Majesty's Service. Such wholehearted encomium may be looked upon as a fitting close to a most dramatic chapter in wireless history.

Lying Aerials

The Nerve Centre of Germany's Wireless Propaganda



THE GREAT WIRELESS STATION OF NAUEN (NEAR BERLIN), FROM WHICH INSTRUCTIONS WERE SO FREELY RADIATED TO THE PREDATORY SUBMARINES.

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Notes of the Month

A Belgian Farewell Dinner.

After the capture of Brussels by the Germans the Société Anonyme Internationale de Telegraphie Sans Fil "carried on" in London during the four years of world-wide struggle, and from welcome guests became everyday working comrades of the staff of the British Marconi Company. When Belgium was cleared under the terms of the armistice, they announced their intention of returning to their own home at 13 Rue Brédérode, Brussels, and gave a farewell dinner at the Savoy Hotel on December 23rd last. It was a most agreeable function, and the notable feature thereof consisted of genuine cordiality. Mr. Isaacs took the chair, supported by four directors of the British Marconi Company, Mr. Alfonso Marconi, Captain Sankey, Mr. Bradfield and Mr. Bramston.

The two principal speeches of the evening were contributed by the Chairman, and by M. Hubert, who had conducted the S.A.I.T.'s operations in England during the war with marked success. Mr. Isaacs, after adequately voicing the feelings of the British Marconi Company, made the interesting suggestion that an excellent way towards carrying out the principle of making Germany pay would be to force them to contribute a sur-tax upon every letter and every telegram which left the confines of their territory. M. Hubert's reply was delivered partly in French and partly in English, and expressed in terms wherein emotion was masked under the cloak of dignified diction, the feelings inspired in himself and his companions by the trials to which they had been subjected and by the spirit of cameraderie displayed on this side of the Channel.

World-Wide Mourning.

Although his intimate friends knew that ex-President Roosevelt's health had been indifferent for some time, to people in general his death came like a thunderbolt from a clear sky.

It is hardly too much to say that it constitutes a subject of world-wide mourning, and no tribute more fitly represents the feelings of us all, put in a few words, than does that paid by Senatore Marconi, which runs as follows :—

"In Theodore Roosevelt the United States has lost one of the most forceful "and magnetic personalities of our time—a man whose broad views and liberal-"mindedness were fully appreciated, not only in his own country, but all the world "over. Personally, I grieve deeply at the loss of a valued friend."

A New Publication.

The International Radiotelegraphic Bureau at Berne published in April, 1918, the fifth edition of their list of radiotelegraph stations of the world, and to date eight monthly supplements have been issued. The net price is 5 fr. 50 c. per copy.

Cuban Wireless Station Rebuilt.

In September, 1917, a hurricane devastated the Island of Pinos, which lies just south of Cuba, and totally destroyed the radiotelegraph station erected at Nueva Gerona. A new station has now been installed, and was put into operation on August 24th last. It possesses a range of 5-600 miles by day and 1,000 miles by night. The tower, 250 feet high, was supplied by the Marconi Wireless Telegraph Company. It would appear that the new station possesses a marked superiority

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over the old. We understand that messages can be transmitted direct to the United States *via* Washington (N.A.A.) during the night, but that they should be forwarded *via* Havana in daylight hours.

FRENCH COAST STATIONS.

We learn from Circular Letters Nos. 72 and 73 of the Berne Bureau that the French Administration have advised that French coast stations are now open for the exchange of radiotelegrams in plain language—either French, English or Italian—concerning the movement and safety of steamships, as well as for wireless messages of a similar character between captains of ships and their owners or agents.

A SUGGESTION FROM WASHINGTON.

The Department of Commerce at Washington have placed before the International Radiotelegraphic Bureau at Berne a proposal to add to the list of abbreviations annexed to Article XXII. of the International Radiotelegraph Regulations call letters to represent the following abbreviations :—

1. What is my true bearing ?
   Your true bearing is.....degrees.
2. What is my position ?
   Your position is.....latitude.....longitude.

These would, of course, be added to the Q.T. series for abbreviated service working.

The American Administration, in support of these proposals, point out that abbreviations of this character will become necessary, owing to the fitting at coast stations of instruments permitting determination of the bearing or position of ships at sea. These suggestions are to be open for the observations, amendments or counter-proposals of Signatories to the Convention until May 1st, 1919.

"THE PROBLEMS OF AGILITY."

We have received from the publishers, the Anglo-French Music Company, an interesting publication (1s. 3d. net) under the above title which is well worthy of the attention of our readers.

This little pamphlet is a summary of the laws governing the speed in reiteration and succession for wireless operators, telegraphists and others. It should appeal particularly to teachers of telegraphy and wireless, dealing as it does with the proper and accurate timing and cessation of the muscular actions, the use of the correct muscles concerned, ease and freedom in the action of those muscles and other similar matters. Obviously the laws which govern rapidity of the reiterated actions called for in wireless and ordinary telegraphy are identical with those governing speed in the utterance of successive notes and repetitions in pianoforte playing, and the author has brought to bear upon the subject his wide experience in musical matters.

A SPECIALIST IN NARROW ESCAPES.

The P.S.N.C. liner *Orduna*—in pre-war days one of the pet boats of this famous steamship company—has during the war established a high repute for hairbreadth escapes, and it seems the irony of fate that she should have become involved in a collision during her first " peace trip " from New York.

On one occasion Captain Taylor, who commands her, was steaming, with 600 French reservists and a large number of British Volunteers on board, through the tracks of the *Dresden* and *Karlsruhe*, what time those predatory vessels were still on the prowl. Of course she travelled through the night with all her lights switched off, and at a critical point of the journey—in order to keep the enemy more completely " in the dark "—the ingenious commander called up an imaginary ship by wireless, and informed a non-existent brother-captain that the *Orduna* was leaving important letters for him at Las Palmas. Of course the Germans intercepted the message, and—as it may be supposed—made the necessary arrangements to catch the *Orduna* off the Canary Islands. In the meantime the wily Britisher shaped his course 30 miles westward of the group, and reached Lisbon in perfect safety.

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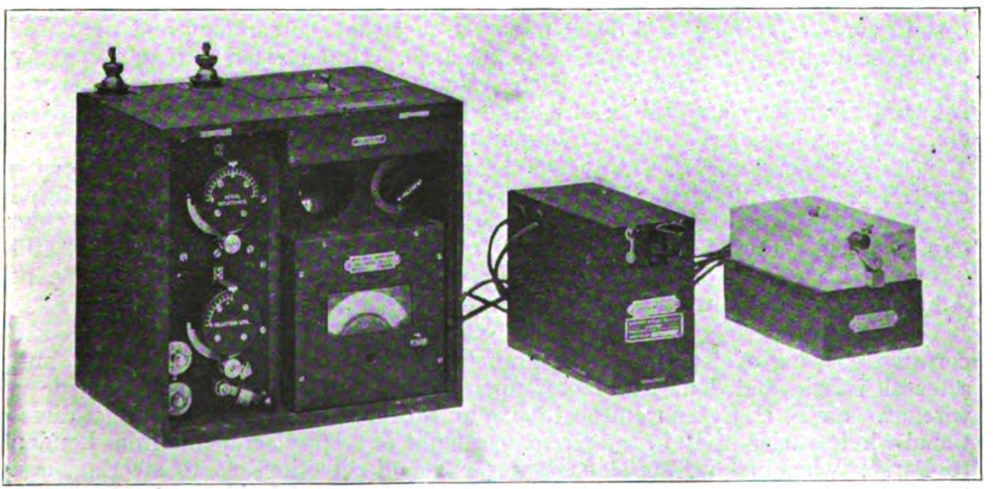
Wireless in Air Navigation

The Important Part to be Played by Radiotelegraphy in the Aerial Ocean

The writer of this article desires to express his obligations to MR. HANDLEY PAGE, not only for the loan of photographs, but for many valuable and instructive remarks and hints, some of which are embodied in the text.

THE modern division of matter—leaving on one side the unique and all pervading ether—is dichotomous. That is to say, it assumes two forms: (*a*) solid, and (*b*) fluid, sharply divided from one another by their elastic properties. Air and water fall under the same division, and that is the reason why we find the practical problems affecting both to be similar. We are, from the point of view of everyday problems, as well as that of scientific theory, absolutely accurate in speaking of the "Ocean of Air."

It is curious to observe how the advent of radiotelegraphy has affected human endeavour in its relationship to the various forms assumed by matter. Land transport was able to attain a high degree of excellence and development long before the possibilities latent in ether waves were realised, although radiotelegraphy is increasingly being used in conjunction therewith. Much also was effected in the world of water-borne traffic; although the systematised organisation thereof suffered very serious disabilities owing to the lack of inter-communication, and ran the gauntlet of a number of risks due to the same cause. Wireless has performed wonders with regard to the Sea Services already, and is certain to do much more later on. But it put in an appearance at a comparatively late stage. With regard to air, however, it would almost appear as though men, before they undertook to wrestle seriously with the immense difficulties which confronted them, had been waiting for Marconi! The sea, at all events, has its islands, its capes, its



MARCONI CONTINUOUS WAVE AIRCRAFT TRANSMITTING SET.

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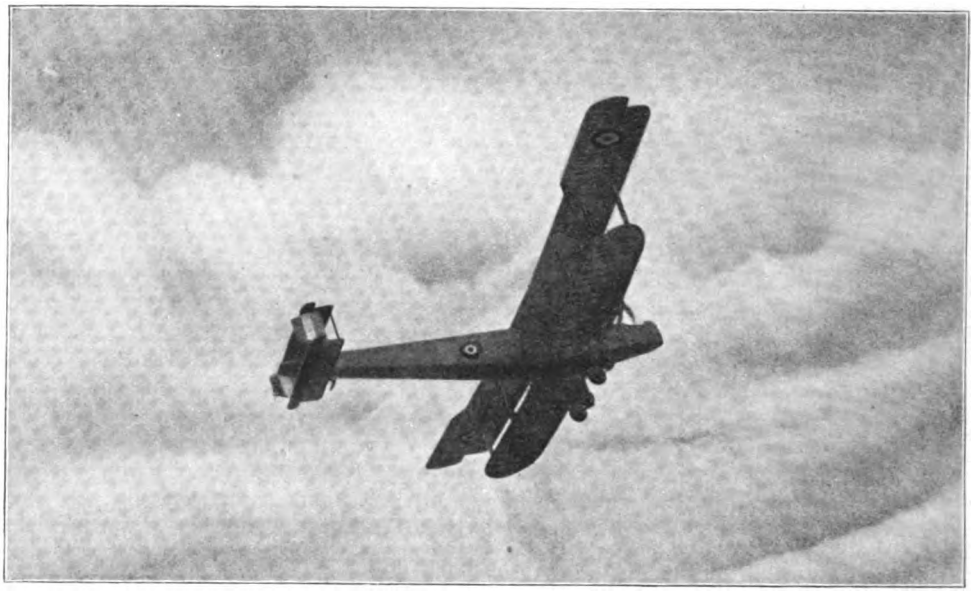

A HANDLEY-PAGE MACHINE IN FLIGHT.

THESE MACHINES WILL BE ABLE TO CARRY ABOUT A COUPLE OF TONS OF MATERIAL ON EACH TRIP. THE LARGER 4-ENGINE HANDLEY-PAGE CAN, OF COURSE, CARRY MORE THAN TWICE THIS LOAD.

mountain heights, and similar *points d'appui* for communication with vessels engaged in voyaging. The air possesses none of these.

We would recall to the recollection of our readers Lord Montagu of Beaulieu's lecture on the future of air navigation, delivered at the Central Hall, Westminster, on June 21st, 1917, in which he emphasised the convenient situation of British possessions for an organised Air Service; touched upon the necessity of the establishment of fixed "lanes" or zones of flight, with specific altitudes allotted to certain types of traffic; and dwelt upon the fact that meteorology and the study of wind-currents will be of supreme importance. He adverted also to the many organic arrangements involved in such systematised flying—instancing the establishment of air police, a system of lighthouses for air pilots, traffic-control centres, etc. The whole plexus of such an organisation hangs upon radiotelegraphy.

Major-General Sir F. H. Sykes, speaking on January 8th last, dwelt with especial insistence upon the influence of the weather upon aviation, and pointed out that, for this reason, a night service was often less liable to interruption than day service. "Flying through clouds," said the Chief of the Air Staff, "still "remained a matter of much difficulty, owing to the entire loss of all sense of "direction, until the introduction of the *turn indicator*."

Scientific instruments of a similar nature for the facilitation of flying are constantly being evolved from the brains of our ingenious experimenters; but, after all is said and done, the factor upon which most reliance must be made is wireless. Sir F. H. Sykes went on to give an excellent example of the use of directional wireless telegraphy in the recent test flight of a large aeroplane from London to Paris; wherein "an aerial navigator gave all directions as to steering, and "stated periodically where the machine was, *without ever looking out*. Paris was "reached in a fog within five minutes of the time calculated by the navigator.

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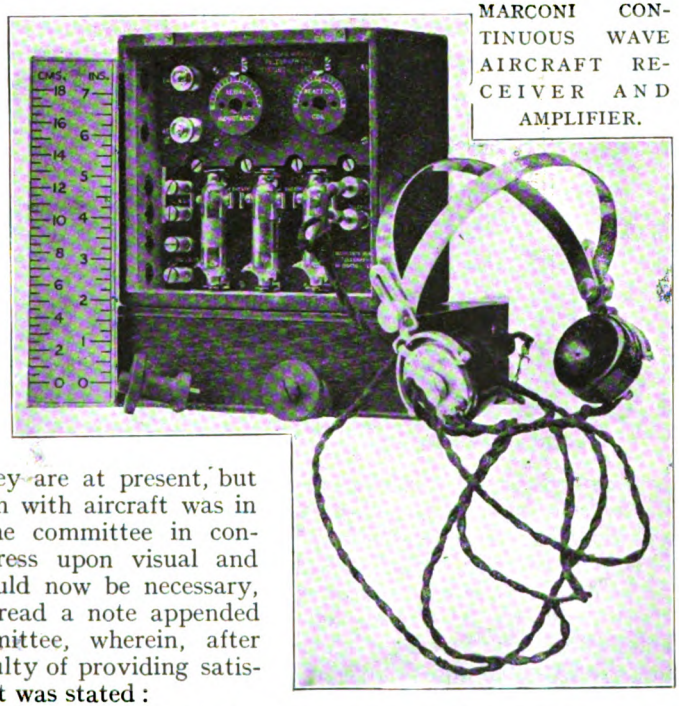
" On the return journey the officer, when he stated that the machine should be over " Brighton at that moment, was found to be less than a mile out in his calculation."

The gallant Major-General, like Lord Montagu of Beaulieu, dwelt upon the necessity for aerial lighthouses or " wireless beacons, unaffected by fog, and with a " range of visibility of six or seven hundred miles. Their cost would be high ; perhaps " in the neighbourhood of £60,000 or £70,000 per station ; but for aircraft they were " primary requirements."

It has possibly escaped the recollection of some of us that an International Convention, in regard to aerial navigation, was held in Paris in 1910, and that a report was issued by the Civil Aerial Transport Committee appointed by that Convention. This report was printed *in extenso* by *Flight* in their issue of December 26th last. The subjects therein dealt with, indicate the complex nature of the problems involved. They may be summarised as : (1) nationality and registration ; (2) certificates of navigability and licences ; (3) territorial boundaries and rights ; (4) flight laws and regulations, rules of the road, landing and distress signals, etc. ; (5) customs and tariff restrictions ; (6) national air services ; (7) punishment for offences. At the time when this report was issued, not only were aeroplanes in a much more primitive stage of development than they are at present, but wireless in its connection with aircraft was in a similar situation. The committee in consequence laid more stress upon visual and audible signals than would now be necessary, and it is instructive to read a note appended by the Special Committee, wherein, after dwelling upon the difficulty of providing satisfactory audible signals, it was stated :



MARCONI CONTINUOUS WAVE AIRCRAFT RECEIVER AND AMPLIFIER.

It is understood, however, that the possibility of providing aeroplanes with magnetic or wireless signalling apparatus is now being investigated, and should any simple system be successfully devised, the Special Committee think that an International Regulation enforcing its use would be desirable.

Now that the new organisation for developing an air service for passengers, mails, parcel-post and parcels delivery appears upon the point of being consummated, such a pronouncement as that recently made to a representative of the Press Association by Mr. Godfrey Isaacs possesses peculiar interest. This eminent *entrepreneur* announces that the Marconi organisations under his control are in a position to supply every aeroplane with a combined wireless telegraph and telephone installation, as well as an efficient and thoroughly qualified operator. They are prepared to do this on the same basis as has been for years past in operation with regard to ships at sea—that is to say, that the Wireless Company will install apparatus suitable for the purpose, will keep it abreast of the most modern develop-

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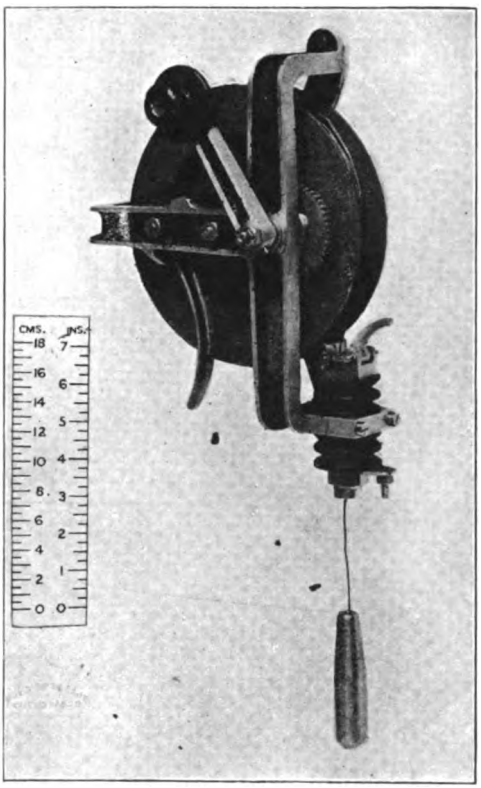
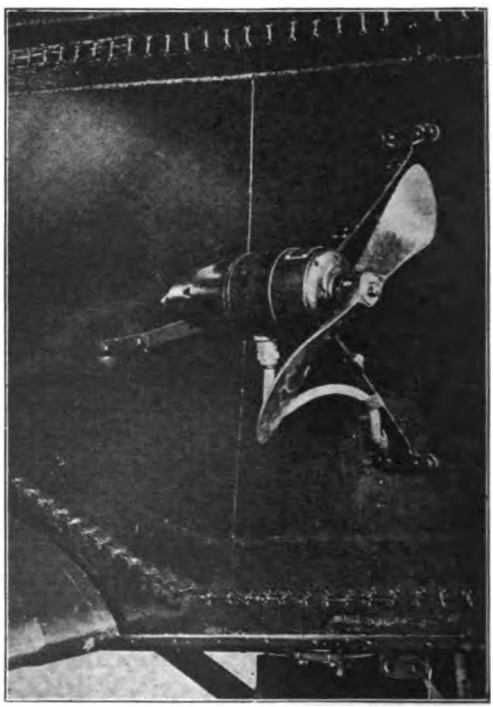


AERIAL WINDING REEL.

of time the air will become as systematically charted with regard to currents and disturbances as the sea with regard to ocean streams, tides and depths. There can be little doubt that such air charts will (as has been repeatedly emphasised by first-class authorities like those quoted above) not only prove of supreme importance for aerial operations, but also will assist navigators at sea. Moreover, the general meteorological information thus made for the first time available, cannot but render incalculable assistance to agriculturists and other members of the community ashore. The latter object will be furthered by the issue of general weather reports from the different wireless stations, both at home and abroad, towards which the Marconi Associated Companies in foreign lands will systematically contribute. The numerous ships at sea fitted with Marconi installations will contribute ments, maintain it in perfect working condition, and supply an expert telegraphist, all at an inclusive charge.

Charts giving the exact position of a number of wireless stations in all parts of the world will be issued, and the land stations will be furnished with direction finders, so as to be able to give the operator the exact position of the aeroplane, wherever it may be. Air-maps will be provided, wherein space is marked off in zones, each bearing its special number. The aerial operators in the Marconi Service will at given periods send out air reports, and will, in their turn, receive communications of a like nature. From time to time record charts will be issued, embodying the information extracted from these reports, so that in course



SMALL AIR-DRIVEN DYNAMO ON THE SIDE OF THE FUSELAGE.

TWO GENERATORS OF THIS DESCRIPTION SUPPLY THE CURRENT NEEDED FOR THE WIRELESS AND LIGHTING. THE DUPLICATION OF THESE SETS ENSURE CONTINUANCE OF OPERATION.

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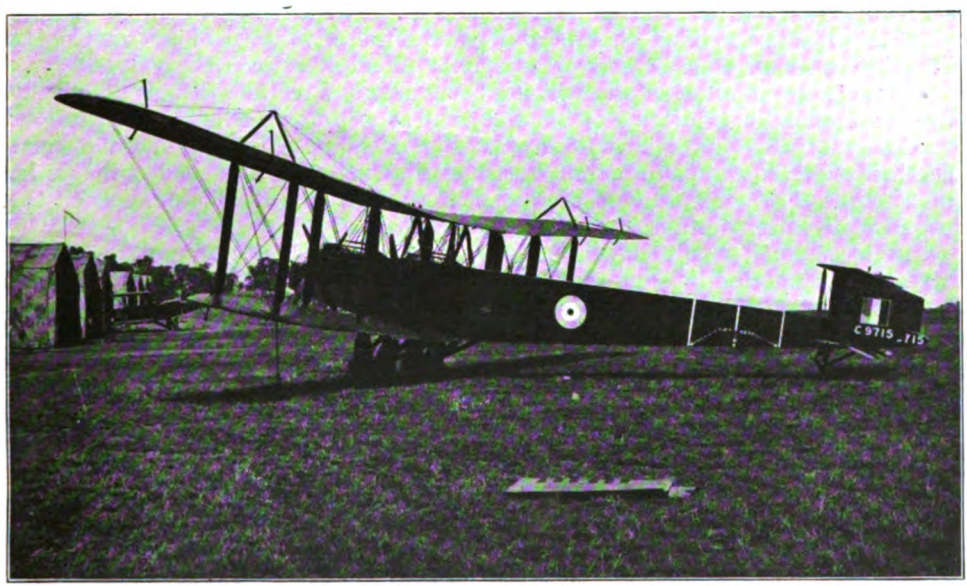
their quota of assistance and play a definite part in the general organisation. Thus do additions to one branch of knowledge benefit all that are inter-related with it.

Even from the point of view of the stay-at-home public, no inconsiderable boon will be conferred by the possibility of thus extending radiotelegraphic communication. They are already able to keep in touch with their private and business friends through the medium of ships' aerials, and the same facilities will be available on aeroplanes as at present on vessels at sea. The former will, like the latter, have accounts current with the Marconi Companies for the transmission of telegrams from the air to any part of the world

We have just witnessed a significant instance of the fashion after which these aerial possibilities will assist in the development of the world. Arrangements were recently made for the erection of wireless stations in the "far-away" parts of China, and a contract for wireless installations has (as already announced in our pages) been concluded with the Chinese Government. These stations are destined to initiate that rapid inter-communication between the various parts of those vast territories which must constitute an essential preliminary to emergence from their present inchoate condition. So great are the difficulties of transport to points at vast distances from the coast and over tracts of land totally unprovided with railways or roads, that Mr. Godfrey Isaacs recently stated he should have hesitated to undertake such a task had not the Air Service come to his rescue. Arrangements made with Mr. Handley Page for the transport of the necessary material by one or more of the big machines which are now being built have put the Marconi Company in the position of conveying their material in two or three days, instead of having to expend the same number of months over the process. We may add the further consideration that by this means alone can be assured the safe crossing of a dangerous tract of country. But for such facilities this promising enterprise would have run the serious danger of being "nipped in the bud."



A PHOTOGRAPH OF A HANDLEY-PAGE MACHINE

SUCH AS ARE TO BE USED FOR THE TRANSPORT OF THE MATERIAL FOR THE CHINESE STATIONS. THE VIEW ILLUSTRATED SHOWS TO ADVANTAGE THE LARGE DIMENSIONS OF THE FUSELAGE (OR BODY) IN WHICH THE APPARATUS AND PLANT ARE TO BE PACKED. THE WINDOW IN THE AFT CABIN IS JUST VISIBLE IN THIS PHOTOGRAPH.

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The Use of Impedance, Capacity, and Resistance Couplings in High-Frequency Amplifiers

By J. SCOTT-TAGGART
Membre de la Société Belge des Electriciens, R.E.

VALVE amplification may be of two kinds: magnification of high-frequency oscillations, and also that of low-frequency current variations. Each form of amplification has its own peculiarities and circuits, although both depend on the fundamental principles of a local circuit current being varied by a separate controlling circuit.

The writer has already described types of circuits used for low and high-frequency amplification (WIRELESS WORLD, January, February, March, 1918). Those used for the amplification of the low-frequency unidirectional pulses produced by the rectification of beats or wave-trains consisted of several valves connected in series or cascade. The plate circuit of one valve was coupled to the grid circuit of the next by means of a step-up transformer. Although this arrangement of intermediary transformers is probably best for low-frequency amplification, it is proposed to show how we may dispense with them in circuits which will be found of very high efficiency as receivers of wireless signals.

The term "high-frequency amplifier," although strictly an arrangement merely for the reproduction of oscillations on a larger scale, very frequently also implies the rectification of these magnified oscillations. The circuits which follow are complete wireless receiving circuits and possess the advantage of not employing either intermediary transformers or oscillatory circuits between the valves.

In the plate circuit of a valve which is being used as a rectifier there is practically always an oscillating variation of plate current as well as an average decrease—or sometimes increase—for each wave-train. Fig. 1 shows a number of wave trains and their effect on the plate current of a valve having a "leaky condenser" in its grid circuit. The oscillations in the plate circuit are shown superimposed on the drop in plate current produced by each wave-train.

In the case of a circuit where the first valve is used as a detector, and subsequent valves, interconnected by step-up transformers, are used as low-frequency amplifiers of the rectified current, very little use is made of the oscillations in the plate circuit

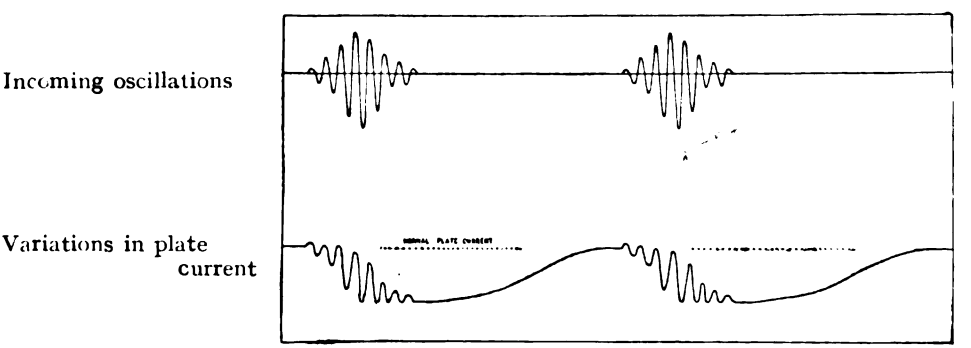

FIG. 1.

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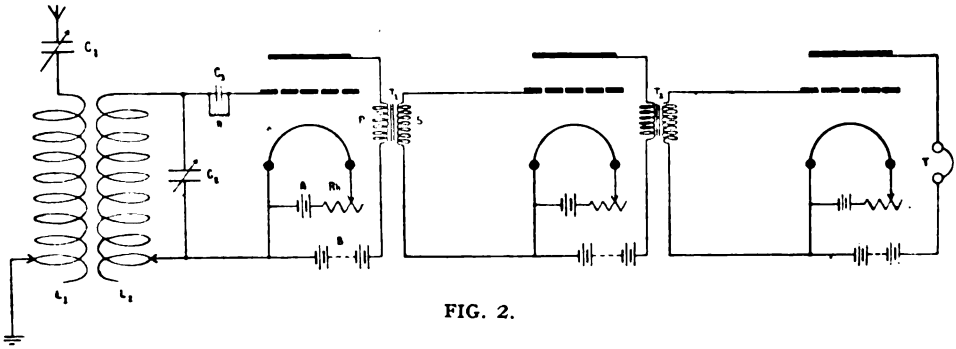

FIG. 2.

of the first valve. Fig. 2 is an example of such a circuit. Another disadvantage of this arrangement is that the rectification of the signals is left chiefly to the first valve which has to deal, when signals are weak, with very small variations of grid voltage. It may be taken as a general rule that the weaker the signals the less efficient is the valve as a detector, since the bends of both grid and plate characteristic curves are comparatively blunt. Signals which are inaudible in the plate circuit of the first valve are not likely to be reproduced efficiently in the plate circuit of the last valve. Rather is it a better principle to strengthen the incoming oscillations to at least the value necessary before the valve detector can be used with any degree of efficiency. Having done this we can *then* apply our oscillating voltages across the grid and filament of a rectifying valve. A common method of augmenting the amplitude and time of duration of wave-trains is that introduced by Franklin, whereby the oscillations in the tuned plate oscillatory circuit are made to react on the original incoming oscillations. Another method of strengthening incoming oscillations is to use a system of amplifying valves with tuned grid and plate oscillatory circuits coupled to each other in the ordinary way. This last method is very selective and requires considerable skill on the part of the operator. In most of the methods described below low and high-frequency amplification takes place at the same time. The circuits of consecutive valves are coupled together, not by the ordinary radio-frequency coupling of tuned circuits or by intermediate transformers, but by means of impedance coils, resistances, and capacity effects. Somewhat obscure reaction effects, which have generally been discovered by accident, such as by the touching of certain parts of the circuit, are also given. These reaction effects,

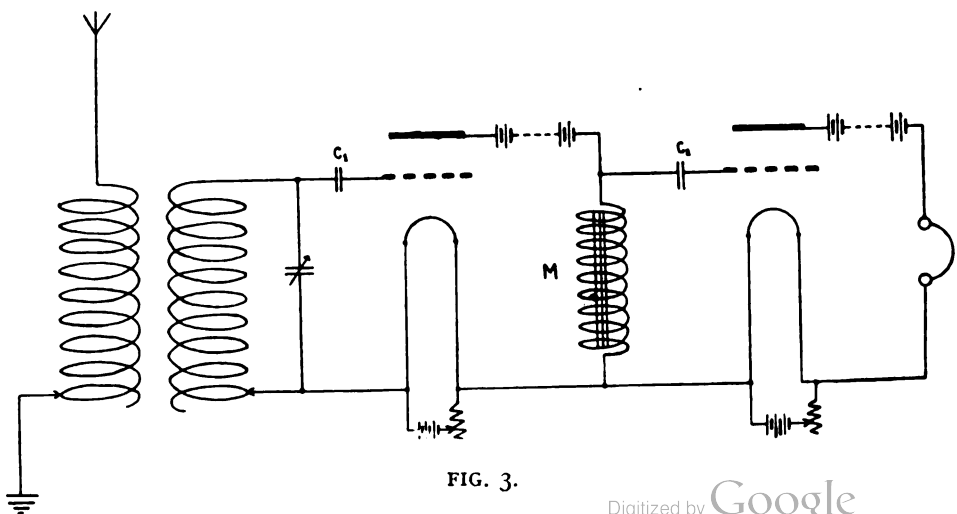

FIG. 3.

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if made sufficiently large, will frequently cause sustained oscillations to take place in the circuits, and, if the frequency of the latter be suitably varied, continuous-wave signals may be heard.

Fig. 3 shows an arrangement, described by A. Hoyt Taylor, in which two audions are coupled together by means of a choking coil *M*. A very small blocking-condenser is used in the grid circuit of each valve. The variable condenser *C* should be of as small capacity as possible. With specially chosen valves the system is capable of oscillating of its own accord and continuous-wave signals may be received. The principle of the choking coil is that it allows the passage of the steady direct current of the plate circuit of the first valve, but tends to stop high-frequency or pulsatory current. The result is that oscillating and pulsating voltages are impressed on the grid of the second valve, producing loud signals in the telephone receivers included in the plate circuit of the second valve. With such a circuit continuous wave signals from Nauen were received at North Dakota, a distance of 10,000 miles, on an aerial 75 feet high.

In place of the choking coil *M* plain resistances have been found effective.

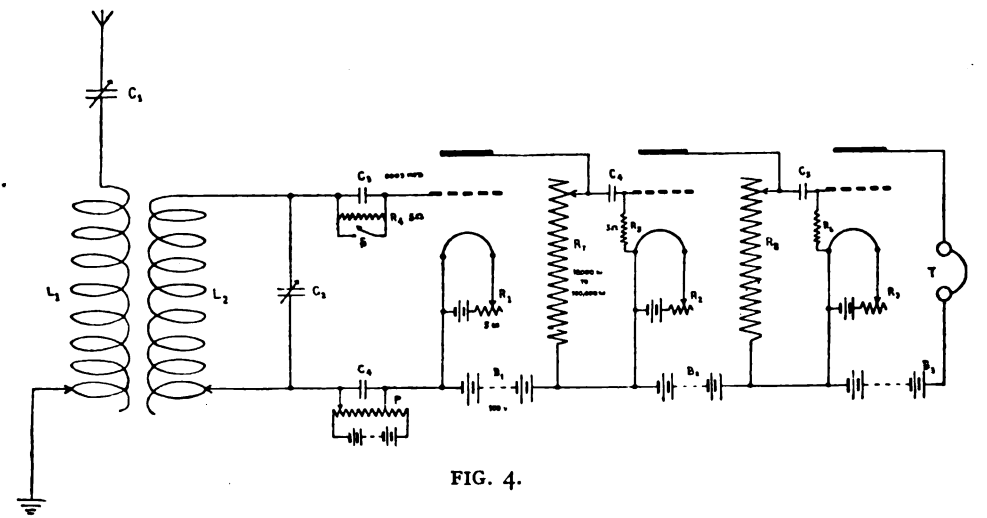

FIG. 4.

Fig. 4 shows an arrangement which has been used with success by the writer. In the grid circuit of each valve is a small condenser *C*, having a capacity of about ·0003 mfd., with a pencil-line resistance of about 5 megohms across the grid and filament. The filament current of each valve is smoothly variable by means of a rheostat of about 5 ohms resistance. In the plate circuit of each valve is a resistance variable by means of studs between the limits 10,000 ohms and 100,000 ohms. This resistance is composed of ten studs mounted radially on ebonite.

Between each pair of studs is connected a pencil-line resistance of 10,000 ohms resistance. These resistances may be constructed by making grooves about 1 in. long on a piece of ebonite with the sharp point of a knife. These grooves are then filled with graphite by simply rubbing an ordinary pencil across them. Terminals are fitted at each end so that good contact with the graphite is made. The terminals are connected to an insulation tester, and the grooved lines rubbed with pencil until the required resistance is obtained.

The function of these plate-circuit resistances is very similar to that of the choking coil in Fig. 3. The oscillations of potential and the slow telephonic current variations are, by their means, communicated to the grid of the next valve.

Instead of using the first valve as a rectifier it may be used almost solely as an amplifier of the original high-frequency currents. A switch *S*, shown in Fig. 4

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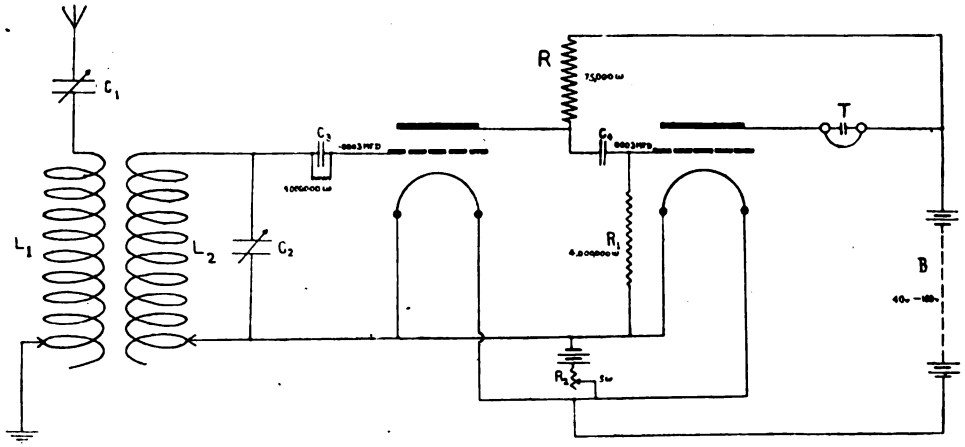

FIG. 5.

enables us to short the leaky grid condenser of the first valve, and the potentiometer *P* enables us to adjust the normal grid potential to a suitable value for pure amplification. In order to allow a free passage for high-frequency currents, a small condenser is shunted across the potentiometer *P*. The values of the plate voltage and filament current of the first valve will probably be different from the values in the case of the other two valves, since the latter are required as rectifiers.

In the plate current of the last valve is connected a pair of high-resistance telephone receivers. It is, however, preferable, as in all valve circuits, to use a step-down telephone transformer in conjunction with low-resistance 'phones.

Fig. 5 shows another receiving circuit capable of good amplification and utilising a pencil-line resistance to couple the two valves together. Both valves are used as rectifiers and have leaky condensers in their grid circuits. In the case of the second valve, the "leak," which is of about 4 megohms resistance, is of necessity connected directly across grid and filament instead of across the grid condenser. The resistance *R* is fixed, and has a value of 75,000 ohms, which has been found to give good results. If convenient, however, it should preferably be variable about that value. It will be seen that only one high-tension battery of 100 volts and one lighting accumulator is used for both valves. The telephone receivers are connected in the plate circuit of the second valve. With this arrangement oscillating potentials are set up across the resistance *R* having a frequency equal to the frequency of the incoming signals. At the same time there are comparatively slow

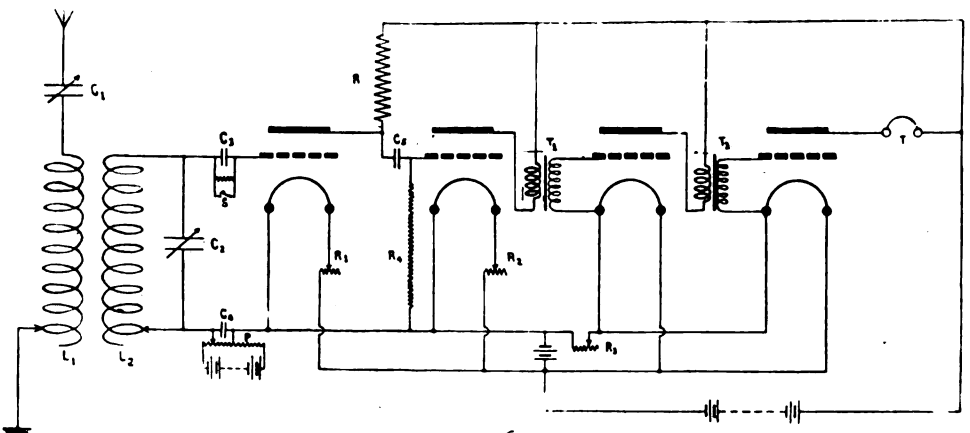

FIG. 6.

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pulsating voltages, due to the rectifying action of the first valve. The frequency of these pulses is equal to the spark-frequency of the transmitting station or the beat-frequency of heterodyned continuous-wave signals, as the case may be. The magnitude of this pulsating voltage across *R* is proportional to the square of the voltage on the grid of the valve due to incoming signals.

At the foot of *R* we have, therefore, voltage impulses of both high and low frequency, and these are communicated to the grid of the second valve, in the plate circuit of which the amplified low-frequency pulses are detected by the telephones *T*.

It is found that such a circuit is more efficient for the reception of long waves than short waves. This is probably due to the impedance being insufficiently great for high frequencies. The capacity in the valve itself acts in parallel with the resistance *R* and lessens its effective impedance for oscillations of high frequency. By shortening and separating all connecting leads and using valves which have small capacity effects between different parts less inefficiency is experienced on short wave-lengths.

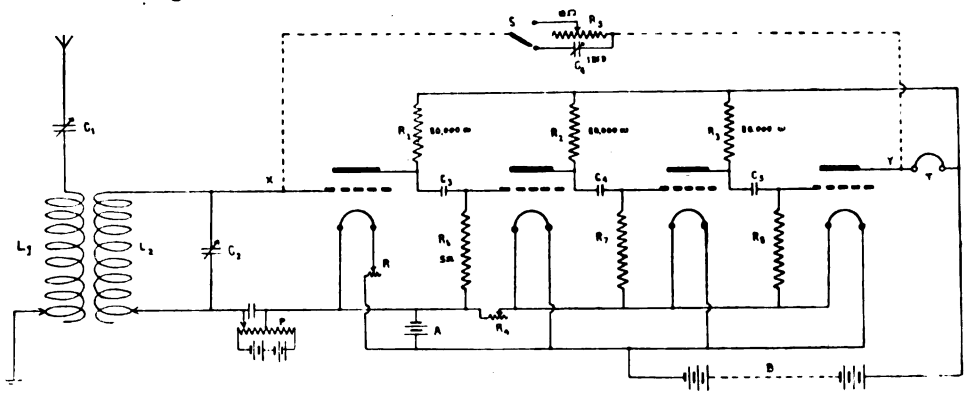

FIG. 7.

It may be as well to emphasise once again the need to cut down as much as possible the capacity of the closed circuit to which the first valve is connected. The condenser which is used to tune the circuit should only be large enough to give sharp tuning, most of the adjustment being done on the variable inductance.

Fig. 6 is a modification of Fig. 5. Two more valves are connected for the purpose of amplifying the low-frequency rectified pulses taking place in the plate circuit of the second valve. Instead of the telephones of Fig. 5, we have a step-up transformer, having a primary resistance of about 2,000 ohms, and a secondary of about ten times that resistance. This secondary winding is connected across the grid and filament of the first low-frequency amplifying valve, the plate circuit of which is likewise coupled by means of a step-up transformer to a second valve.

Another feature of the circuit is the grid condenser shorting switch *S* and the potentiometer *P*. The arrangement of Fig. 6 is not shown as a circuit to be specially recommended, but rather as an example of how different forms of amplification may be obtained and utilised in the same receiving circuit, using one accumulator and one high-tension battery. When the potentiometer of Fig. 6, for example, is used, the first valve is almost purely an amplifier of high frequency oscillations. The second valve is used as a rectifier and the last two valves as low-frequency amplifiers.

Fig. 7 is a four-valve amplifying circuit of great efficiency. We are now using three coupling resistances, each of 80,000 ohms resistance. The arrangement is simply a development of the Fig. 5 circuit. The first valve is adjusted by means of a potentiometer *P* and a separate rheostat *R* to a point on its plate and grid characteristic curve suitable for pure amplification of the oscillations taking place in the closed receiving circuit.

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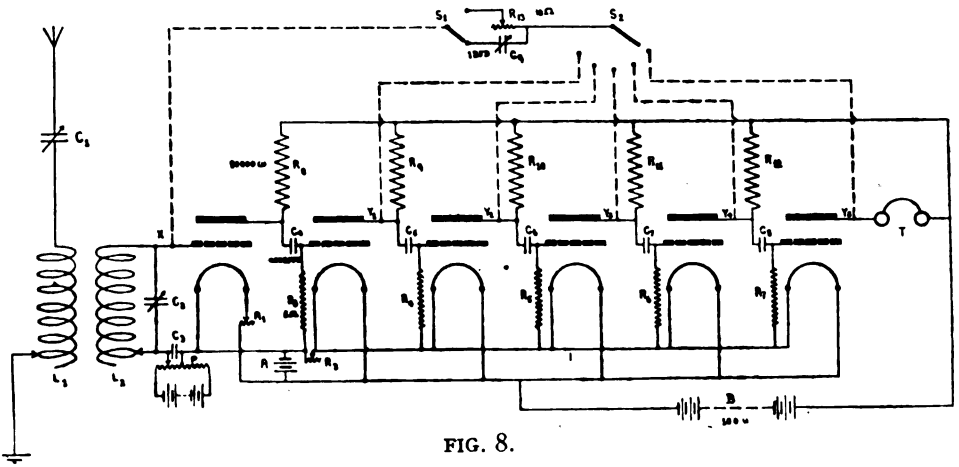

FIG. 8.

High-frequency pulses are produced at the foot of R_1, and are impressed on the grid of the second valve. This valve and the two remaining ones act as high and low-frequency amplifiers and have leaky condensers in their grid circuits for rectification purposes. Since their functions are alike, their filament currents are controlled by a rheostat R_4, common to all; the telephones are connected in the usual way in the plate circuit of the last valve.

A very interesting and valuable effect may be obtained in circuits of this type. The strength of signals is appreciably increased by producing a reaction effect from the plate of the last valve to the grid of the first one of the series. This may be accomplished by means of a very small variable condenser, or by a very high resistance. The former method is an example of capacity reaction coupling which is frequently met with in circuits which tend to oscillate of their own accord. By increasing the value of the small variable condenser the system can usually be made to pass through the regenerative stages prior to the point of instability at which maintained oscillations establish themselves. The dotted line in Fig. 7 shows the connections. A two-way switch allows for either the use of a very small reaction condenser or a resistance variable about a mean value of 10 megohms.

In Fig. 8 we have a six-valve circuit which is designed on the same lines as the one in Fig. 7, except that still further amplification is obtained. The first valve is used purely as an amplifier, and has a separate rheostat. The remaining valves act as rectifiers and high and low-frequency amplifiers. A five-way switch is provided which allows, for experimental purposes, the reaction resistance or condenser to be used from the grid of the first valve to the plate of the second, third, fourth, fifth, or sixth valve. By adjusting this reactance the circuits can usually be made to oscillate of their own accord. To tell when this is occurring it is only necessary to bring near the circuits an oscillating wave-meter, the design of which was first described by the writer in THE WIRELESS WORLD of October, 1917. On turning the wave-meter condenser round to "cut through" the wave-length of the oscillating circuit, a "chirp" should be heard. Even if the circuits are not oscillating, continuous-wave signals may be received by using the wave-meter for heterodyning the incoming oscillations; this will probably give even better results.

It will frequently be found, when dealing with circuits of this type, that various obscure reaction effects are produced by touching some part of the circuit. Signals are strengthened, but revert to their normal strength on taking the hand away. Such effects can generally be replaced and made permanent by connecting either a high resistance or small capacity across the part touched, and, say, the earth, the metal part of the head-gear or other point of the circuit found by trial.

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Among the Operators

Although, happily, the loss of life at sea by enemy action has ceased, it is still our melancholy duty to record the names of operators who have lost their lives by accident and natural causes. The recent epidemic has taken heavy toll of Marconi men both at sea and on land. Mr. L. S. Craig was drowned at Gibraltar whilst bathing, on October 20th, 1918, and the remainder whose names are mentioned this month have died from natural causes. Both for our own part and that of our numerous readers we extend to the parents and relatives of these young men the deepest sympathy in their sad bereavement.

Born at Lewisham on August 7th, 1888, WARRANT TELEGRAPHIST ARTHUR JOHN REYNOLDS, R.N.R., was educated at St. Mary's School, Lewisham. He entered the service of the South-Eastern and Chatham Railway Company, Limited, after leaving school, and served with them for six years, joining the Marconi School at Seaforth for training in wireless telegraphy in September, 1909. Mr. Reynolds served on many ships and was well thought of by his commanders. He had also a period of duty at the Clifden high-power station. On August 4th, 1914, he joined up for naval duty, and reported to the Commodore, Naval Barracks, Devonport, for instructions. During the war he performed his duty with distinction, but unfortunately died on October 28th, 1918, of pneumonia.

MR. CLIFFORD WILLIAM PERKIN was born at Buxton on November 3rd, 1880, and educated at Buxton College. He was appointed telegraphist in the Buxton Post Office, transferring thence to Manchester. He served in the Boer War as Telegraphist R.E., from June, 1900, to May, 1902, after which he entered the Civil Telegraph Service of the Transvaal, and ultimately that of the British East Africa Protectorate. Indifferent health compelled him to return to his native land, and after a period of recuperation he joined the Marconi Seaforth School, being appointed to the staff as a seagoing operator on October 19th, 1910. Mr. Perkin was an expert telegraphist, widely known among the older men for his skill and personality. He held the Queen's and King's South African medals, and twice suffered torpedoing during the period of the war, dying in harness, at sea, of influenza, on October 11th, 1918.

MR. LESLIE SCOTT CRAIG was born at Inverallochy, Aberdeenshire, on December 8th, 1898, and went to the Public School, New Pitsligo, Aberdeen, for his education. His training in wireless telegraphy was received at the North British Wireless Schools, Limited, Glasgow, and after obtaining the P.M.G. Certificate Mr. Craig commenced his services with the Marconi Company in January, 1917.

In his eighteenth year, MR. ALEC CHARLES GILLIES was born at St. Giles-in-the-Wood, Leigh, North Devon, and received his education there and at Wallingbrook Secondary School. In order to relieve his brother for service with the army, he filled his place as gardener, subsequently attending the Marconi House School for training in wireless telegraphy, where he gained the P.M.G. Certificate and was appointed to the seagoing staff of the Marconi Company last May. Mr. Gillies succumbed to pneumonia on October 14th, 1918.

MR. HERBERT SAMUEL WALL was born at Ledbury on March 12th, 1901. He was educated at West Malvern School and trained under Marconi instructors at the Municipal Technical School Extension, Birmingham, in wireless telegraphy, where he qualified for the P.M.G. Certificate. On gaining the latter he was placed

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ROLL OF HONOUR.

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on the operating staff of the Marconi Company in June, 1918. Mr. Wall died of dysentery at Calcutta on October 21st, 1918.

Coatbridge, N.B., was the birthplace of MR. JAMES BROWNLIE on July 27th, 1895. After receiving his education at Bellshill Academy, he became a steel worker at the Mossend Steel Works. His wireless training was received at the North British Wireless Schools, Limited, Glasgow, and after passing the P.M.G. examination for his certificate, he joined the operating staff of the Marconi Company in March, 1917. Mr. Brownlie died at sea of influenza on October 18th, 1918.

MR. ARTHUR ERIC ARRAN, born at East Macclesfield on August 27th, 1899, was educated at Burnley, and commenced his career with the Whittlefield Mill Company, Limited, in that town. His wireless training was received at the City School of Wireless Telegraphy, Manchester, and on receipt of the P.M.G. Certificate he proceeded to sea as a Marconi operator in December, 1917. Mr. Arran's demise was from pneumonia following influenza.

MR. FRANK GULLEN was born on August 2nd, 1890, at Limerick, and was a pupil at the Limerick Model National School, and Closes's Intermediate School. After completing the curriculum of the latter, he took up a position as a commercial clerk, leaving it to embrace wireless as a career, and was trained in radiotelegraphy at the Atlantic Wireless Telegraph College, Cahirciveen. Mr. Gullen was given the P.M.G. Certificate in November, 1913, and then entered the service of the Marconi Company. His death, which took place on October 30th, 1918, was also due to pneumonia following influenza.

Born at Finniterstown, co. Limerick, on June 23rd, 1900, MR. JOHN JOSEPH JONES was educated at the National School, Skeheenarinky, co. Tipperary. He attended the Irish School of Telegraphy, Cork, and there qualified for the P.M.G. Certificate. After its award Mr. Jones joined the Marconi Company's service in March, 1918. His death on October 26th, 1918, was from pneumonia following influenza.

Formerly a boy telegraphist in the Royal Navy and serving on board H.M.S. *Impregnable*, H.M.S. *Vernon*, and at the Royal Naval Barracks, Chatham, from whence he was invalided out of the service, MR. FRANK LESLIE DELLAR was born at Kensington on January 21st, 1899, and educated at the Royal Hospital School, Greenwich. His service with the Marconi Company dated from November 21st, 1915, and continued until the time of his death on October 25th, 1918, which took place from heart failure following influenza, on board the s.s. *Sagama River*, at Greenock.

Born at Llandudno on September 13th, 1898, MR. JOHN STANLEY LEVIS was educated at the Duffryn Road Council School, and "The John Bright" County Secondary School in the same town. He was employed for a time as salesman with Messrs. Hogg and Mitchell, of Manchester, after which he became a student at the City School of Wireless Telegraphy, Manchester. When possessed of the P.M.G. Certificate, Mr. Levis was placed on the seagoing staff of the Marconi Company in June, 1907. The cause of death, at sea, was fever.

MR. TIMOTHY REGAN was born at Glandore, co. Cork, on September 9th, 1891, and attended Glandore Boys' School and Skibbereen Collegiate School for his education. He was a competent yachtsman, and sailed on several well-known private yachts before attending the Liverpool Wireless Telegraph Training College, where he gained the P.M.G. Certificate. Mr. Regan was placed on the operating staff of the Marconi Company in February, 1916. He died of pneumonia on October 31st, 1918.

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Instructional Article

NEW SERIES (No. 11)

EDITORIAL NOTE.—Below we give the eleventh of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

THE QUANTITATIVE MEANING OF SYMBOLS AND FORMULÆ.

The Relative Combining Weights of Elements.— It has been explained that chemical formulæ show the proportions in which the atoms in compound molecules have combined, because of the fact that they are written according to an agreed method, each symbol representing a certain number of atoms and each formula a certain number of molecules. Thus, taking the case of manganese dioxide, the formula for which is MnO_2, the student is now able to see at once that a molecule of this material is composed of manganese and oxygen in the proportion of 1 atom of *Mn* to 2 atoms of *O*.

This kind of information is, however, insufficient to give us a practical working idea of the proportion of each element in a compound. Suppose we wish to prepare a *certain quantity* of a compound, say of copper sulphate ($CuSO_4$) for use in a Daniell's cell; if we know nothing more about the amount of each ingredient required than that we must bring them together in the proportions of 1 atom of copper, 1 atom of sulphate and 4 atoms of oxygen, we shall find ourselves faced with an impossible task and shall be forced to work in the dark. Even if we know that a practical method of making copper sulphate is to dissolve copper in sulphuric acid, how are we to decide how much of these materials to use in order to produce the quantity of sulphate needed? The equation representing the action is

$$Cu + 2H_2SO_4 = CuSO_4 + SO_2 + 2H_2O$$

and, as will be shown presently, this and a knowledge of the atomic weights of the four elements concerned will enable us to overcome the difficulty.

We know that the atomic weights of elements are *relative* weights; therefore, as the symbol of an element means 1 atom of that element we can consider it to mean also *a number of relative parts by weight*, the number being the same as that representing its atomic weight. For example, as the atomic weight of hydrogen is 1·008, its symbol, *H*, means "1·008 relative parts by weight of hydrogen"; and H_2 means "2·016 relative parts by weight of hydrogen." Taking the case of a formula, say $ZnSO_4$, we understand this to mean that zinc sulphate is composed of 65·4 parts by weight of zinc, 32 parts by weight of sulphur and 64 parts by weight of oxygen. Thus, if zinc sulphate could be made by merely bringing these three elements directly together we should know that to produce $(65{\cdot}4+32+64)=161{\cdot}4$ parts by weight —tons or ounces or grammes—of this compound, we should need 65·4 tons, ounces or grammes of zinc, 32 tons, ounces or grammes of sulphur and 64 tons, ounces or grammes of oxygen. It does not matter what weight we make the "parts" so long as all the "parts" are of equal weight.

Emergency Preparation of $CuSO_4$ for Daniell's Cell.—Returning now to this

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question, by simple calculation from the atomic weights we find from the equation $Cu+2H_2SO_4=CuSO_4+SO_2+2H_2O$ that

63 parts Cu+196 parts H_2SO_4=159 parts $CuSO_4$+64 parts SO_2+36 parts H_2O.

Hence it is evident that to prepare 159 ounces of copper sulphate we must treat 63 ounces of copper with 196 ounces (by *weight*—not *fluid* ounces) of sulphuric acid. Once these proportions are known it is a simple matter to decide how much copper and acid is required to make a given amount of this salt.

Thus it is seen that a chemical equation is also a mathematical equation, both sides being, in the sense just explained, numerically equal. Bringing down the figures of the above equation we get $63+196=159+64+36$, which is correct.

It may be useful to point out that the copper and acid (concentrated) should be very gently and carefully heated together in a chemical glass or porcelain vessel until the action commences; the heat should then be adjusted so that the action continues without undue violence. Clean copper filings, turnings or thin wire should be used, and when it has been dissolved the solution should be filtered if necessary, and evaporated almost to dryness; the residue is then ready for use. If required urgently the copper sulphate need not be brought to the solid state; in this case the solution which remains after the action should be evaporated to saturation point and put straight into the cells.

(1) Use distilled water if possible.

(2) Use slightly more acid than the amount required theoretically.

(3) Avoid the fumes of SO_2 which are evolved; they are extremely pungent. In this connection it is worth mentioning that if an emergency fumigator is required, no sulphur being obtainable, these fumes will serve the purpose efficiently.

Molecular Weights.—Chemical symbols and formulæ serve also as the means of determining the relative *molecular* weights of substances. The symbol O represents an atom of oxygen of relative weight 16; hence O_2, the symbol for a molecule of oxygen, at once gives us 32 as the relative molecular weight. A few more examples follow:—

Water (H_2O)	Relative molecular weight $=(1\times2)+16$	$=18$
Sulphuric acid (H_2SO_4) .	Relative molecular weight $=(1\times2)+32+(16\times4)$	$=98$
Sodium chloride ($NaCl$) .	Relative molecular weight $=23+35$	$=58$
Carbon dioxide (CO_2) .	Relative molecular weight $=12+(16\times2)$	$=44$

These weights in grammes are the gramme-molecules of the substances.

It is sometimes necessary to know the *percentage* of a certain element in a compound and this is easily found if the formula of the latter is known. For example, the percentage of lead in litharge may be calculated as follows. The formula is PbO, which means that $(207+16)=223$ parts by weight of litharge contain 207 parts by weight of lead; hence the percentage is $\frac{207\times100}{223}=92{\cdot}82$ per cent.

The Volume of Gases.—In addition to indicating the relative weights of reacting substances chemical formulæ furnish us with data to determine the relative *volumes* of gaseous substances, but before explaining this we must state the **Law of Avogadro,** which is as follows: **Equal volumes of all gases at the same temperature and pressure contain an equal number of molecules.** We cannot here consider the reasons which led to the enunciation of this law; for our present purpose the reader may accept it as true. The formula for 1 *molecule* of ammonia is NH_3 and from this we know that the relative molecular weight is $(14+3)=17$. The formula for 1 *molecule* of carbon dioxide is CO_2, hence the molecular weight is 44. The formula for 1 *molecule* of hydrogen is H_2, giving us the molecular weight as 2. Here we have the relative weights of three different molecules,

NH_3 . . . . 17 $\qquad$ CO_2 . . . . 44 $\qquad$ H_2 2

and assuming that they are under similar conditions of temperature and pressure,

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by Avogadro's Law the volumes occupied by these molecules are equal. Hence their relative *densities* must be

NH_3 . . . . 8·5 CO_2 . . . . 22 H 1

We may say, therefore, that the relative densities of gases as compared with hydrogen, which is taken as unity, are found by halving their molecular weights.

Now it was shown above how the weight of gas produced by chemical action can be calculated if the weight of the original substances is known, but it is also possible to find the *volume* of gas evolved at standard temperature and pressure if we know its relative density. Measured at 0° C. and 760 mm. pressure a gramme of hydrogen has a volume of 11·165 litres,* and as the density of carbon dioxide is 22 it is obvious that 22 grammes of that gas measured under the same conditions will occupy the same volume as one gramme of hydrogen. This may be further explained as follows: Suppose we pour a liquid into a vessel until a certain mark is reached and then ascertain that that amount of liquid weighs 1 lb.; obviously, if we fill the vessel up to the same mark with another kind of liquid which is 22 times heavier than the first, or, in other words, whose density relative to the first is 22, the weight of the measured quantity of the second liquid will be 22 lbs. Hence *the relative density of any gas, expressed in grammes, gives us that weight of the gas which will occupy a volume of* 11·165 *litres.*

Examples:—

Relative density of a gas $= \frac{\text{Its molecular weight}}{2}$

At 0° C. and 760 mm., $\frac{\text{molecular wt.}}{2}$ grammes of any gas occupy 11·165 litres.

At 0° C. and 760 mm., $\frac{71}{2} = 35{\cdot}5$ grammes of Chlorine occupy 11·165 litres.

At 0° C. and 760 mm., $\frac{17}{2} = 8{\cdot}5$ grammes of Ammonia occupy 11·165 litres.

At 0° C. and 760 mm., $\frac{32}{2} = 16$ grammes of Oxygen occupy 11·165 litres.

From the above it follows at once that *the gramme-molecule of any gas, measured at* 0° *C. and* 760 *mm. pressure, will occupy* $(11{\cdot}165 \times 2) = 22{\cdot}33$ *litres.*

We are now in possession of sufficient data to calculate the volume of a gas evolved as a result of chemical action, provided the equation representing the action is known.

Example.—Suppose we wish to fill a vessel of capacity roughly 50,000 cubic centimetres with hydrogen which is to be prepared by the action of sulphuric acid on zinc. How much zinc must be used?

(*a*) The equation being $Zn + H_2SO_4 = ZnSO_4 + H_2$ we know at once that 65 grammes of zinc will give us two grammes of hydrogen, or, in other words, a gramme-molecule of hydrogen.

(*b*) A gramme-molecule of hydrogen measured at 0° C. and 760 mm. has a volume of 22·33 litres, and as this is produced by the solution of 65 grammes of zinc it is easy to calculate that to obtain the required volume—*i.e.*, 50 litres—we must use about 150 grammes of zinc. From our figures we actually get $\frac{50 \times 65}{22{\cdot}33} = 145{\cdot}5$ grammes of Zn; in practice this amount would be increased in order to compensate for that volume of gas which would remain in the apparatus after the action had ceased.

The volume we have just found, however, is that of the gas at 0° C., a temperature which is not always readily reached; what we really need to know is the volume when the gas is measured at the temperature and pressure at which it is made.

* 1 litre = 1,000 cubic centimetres.

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Ordinary atmospheric pressure at sea-level is 760 mm., and we will assume that the temperature under normal working conditions would be about 18° C. Our problem is to find out how much zinc must be dissolved in H_2SO_4 in order to produce 50 litres of hydrogen at *normal* temperature and pressure.

Charles' (or Gay-Lussac's) Law.— *If the pressure is kept constant the volume of a gas is directly proportional to the absolute temperature.*

Absolute Temperature.—This is the temperature in Centigrade degrees, plus 273°, or, the number of Centigrade degrees above −273° C.—a temperature which has never been attained. *E.g.*, if Centigrade temperature = 60°, the absolute temperature = 60° + 273° = 333°.

From a consideration of Charles' Law it may be seen that the same volume of all gases should increase by the same amount when the temperature is raised 1°; indeed, experiment has shown that this is very nearly true. The constant increase in volume for every degree increase in temperature, the pressure remaining constant, is called the **Coefficient of expansion of a gas,** and is $\frac{1}{273}$ (0·00366) of the volume.

As the volumes are directly proportional to the absolute temperature we can say that,

$$\frac{\text{1st Vol.}}{\text{2nd Vol.}} = \frac{\text{1st Temp. (Abs.)}}{\text{2nd Temp. (Abs.)}}$$

Let 1st Vol. be 1, and 1st Temp. 273° Abs. (0° C.). Then if the temperature be raised 1°, *i.e.*, to 274° Abs., the 1st Vol. will increase to $1+\frac{1}{273}$. Putting these figures into the foregoing equation, we get

$$\frac{1}{1+\frac{1}{273}} = \frac{273}{274},$$

which is obviously a true equation, the general form of which may be written

$$\frac{v_1}{v_2} = \frac{t_1}{t_2}$$

Now our task is to find the increase in volume of 22·33 litres of hydrogen (measured at 0° C. and 760 mm. pressure) if the temperature is raised to 18° C. (or 291° Abs.) while the pressure remains the same; that is, we have to find the value of v_2 in the last equation.

$$\frac{v_1}{v_2} = \frac{t_1}{t_2}, \text{ hence}$$

$$v_2 = \frac{v_1 t_2}{t_1},$$

so that by using our figures we get

$$v_2 \text{ (or the vol. at 291° Abs.)} = \frac{22{\cdot}33 \times 291}{273} = 23{\cdot}8$$

This is the number of litres of hydrogen which the solution of 65 grammes of zinc in sulphuric acid will produce at atmospheric temperature and pressure; therefore to obtain 50 litres of gas we must dissolve

$$\frac{65 \times 50}{23{\cdot}8} = 136{\cdot}5 \text{ grammes of zinc,}$$

although, as was previously mentioned, this quantity would be slightly increased in practice, to allow for the capacity of the vessel in which the gas is made.

NOTE 1.—**Standard Pressure.**—This is a pressure of **one atmosphere**, and will support a column of mercury 76 centimetres high at 0° C. Taking the weight of a cubic centimetre of mercury as nearly 13·6 grammes the standard column of mercury will correspond to a pressure of about 13·6 × 76 = 1033·6 grammes per square centimetre, roughly 14·7 lb. per square inch.

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NOTE 2.—**Density and Specific Gravity.**—Having referred in this article to the *density* of gases it may be useful to point out that this quantity is **mass per unit volume,** whereas *specific gravity* is the **weight of a given body compared with that of an equal volume of water at 15° C.** Supposing we wish to know the specific gravity of some engine oil, we can estimate as follows :—

$$\text{Sp. Gr.} = \frac{\text{Wt. of given vol. of oil}}{\text{Wt. of same vol. of water}}$$

A useful practical standard is, 1 gallon of water weighs 10 lb. Weighing 1 gallon of the oil we find it to be, say, 9 lb.

Hence its Sp. Gr. $= \frac{9}{10} = 0{\cdot}9$ (a ratio only) and a value which corresponds to a light motor oil, too heavy for sewing-machines or spindles but too light for cylinders and heavy shafting. This method is " rough and ready " ; in the laboratory about 50 cc. of water and of oil would be weighed on a fine chemical balance, and the calculation carried to three figures.

If instead of using lbs. and gallons we conduct the experiment in cubic centimetres and grammes we shall arrive at 0·9 just the same, and in this system (C.G.S.) the figure for the Sp. Gr. is also that for the density. Hence the *density* of our oil is 0·9 grammes per c.c. Under the British system density is (Sp. Gr. $\times 62{\cdot}3$) lb. per cubic foot ; therefore the density of our oil may be said to be $(62{\cdot}3 \times 0{\cdot}9) = 56$ lb. per cubic foot.

CONSTRUCTION OF EQUATIONS.

Before leaving the subject of formulæ it is desirable to go briefly into the method of writing equations, the object being to assist the student to construct them for himself and to appreciate fully those which he may encounter in his reading. In order to give the correct equation to a chemical action we must know the composition of the substance or substances taking part in the action and the composition of the final products of the action.

Example 1.—Quicklime is made on a commercial scale by burning chalk in kilns. What equation represents the chemical action involved? Qualitative analysis shows that chalk is calcium carbonate, and quantitative analysis has determined the composition of this substance to be represented by the formula $CaCO_3$. Then, experiment proves that if $CaCO_3$ is strongly heated it breaks up into carbon dioxide and calcium monoxide (quicklime). Putting these facts down in the form of an equation, we get

Calcium carbonate = Calcium monoxide + carbon dioxide

or $CaCO_3 = CaO + CO_2$

(5 atoms) = (2 atoms) + (3 atoms)

Example 2.—Now certain oxides of metallic elements form hydroxides when combined with water, and lime is one of these ; when it is exposed to a moist atmosphere it combines with water to form calcium hydroxide (slaked lime). The equation to this action can be written down at once as

$$CaO + H_2O = Ca(HO)_2$$

The primary thing to be careful of in making equations is the conservation law ; if we have x atoms to begin with—*i.e.*, on the left-hand side—we must have x atoms remaining—*i.e.*, on the right-hand side.

Example 3.—When a hydroxide combines with an acid a salt is formed ; therefore, if we treat calcium hydroxide with hydrochloric acid the products are calcium chloride and water. Writing down

$$Ca(HO)_2 + HCl = CaCl + H_2O$$

we find that we cannot make a correct equation in this case by simply putting the formulæ of the reacting substances on one side and those of the products on the other.

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In fact, what we have just written is not an equation at all, because on the left-hand side we have 7 atoms and on the other side only 5 atoms. Besides this, $CaCl$ is not the true formula for calcium chloride; it should be written $CaCl_2$. The way out of the difficulty is to put $2HCl$ instead of HCl. This gives us the extra atom of chlorine required and also enables us to make a true equation as regards the number of atoms shown on each side. The correct statement is

$$Ca(HO)_2 + 2HCl = CaCl_2 + 2H_2O$$

After writing $CaCl_2$ we find we have to account for 4 atoms of H and 2 atoms of O, and these obviously make up 2 molecules of H_2O. The student may ask how he could be expected to know the true formula for calcium chloride to be $CaCl_2$ and not $CaCl$. A knowledge of the formulæ of compounds is largely a matter of experience and memory; one has to acquire them in much the same way as one acquires a vocabulary. In the case of calcium chloride a knowledge of the **valency** of calcium would enable the student to realise at once that its atom combines with *two* atoms of chlorine. Valency will be dealt with in the next article.

Example 4.—If calcium carbonate (chalk, marble, egg-shell, etc.) is treated with hydrochloric acid the products of the action are calcium chloride, carbon dioxide and water, and if we write this in the simplest way we again find that we get a wrong statement.

$$CaCO_3 + HCl = CaCl_2 + CO_2 + H_2O.$$

Here all the formulæ are correct but the *quantities* are not, there being (*a*) 1 *atom of H in excess on the right-hand and* (*b*) 1 *atom of Cl in excess on the right-hand.* Therefore we write

$$CaCO_3 + \mathbf{2}HCl = CaCl_2 + CO_2 + H_2O.$$

If the action were to be carried out in practice according to the incorrect equation we wrote first, the result would be that the HCl would be insufficient and only half the quantity of $CaCO_3$ present would be decomposed.

Example 5.—When mercuric oxide is strongly heated it decomposes into mercury and oxygen, and the most direct way of writing the equation is

$$HgO = Hg + O$$

But this is wrong, for it shows a *free atom* of oxygen, and we know that a molecule of oxygen—a structure made up of *two* atoms—is the smallest particle of that gas which can exist in a free state. The oxygen molecule being di-atomic the equation must be

$$2HgO = 2Hg + O_2$$

Note that we write $2Hg$ and not Hg_2 because Hg_2 would represent "a molecule of mercury composed of two atoms," whereas the Hg molecule is **mon**-atomic; hence as we have 2 atoms of Hg we also have 2 *molecules* of Hg, and they are represented according to the rule, with the figure 2 preceding the symbol.

Share Market Report

BUSINESS has been extremely quiet during the past month and there is little change to record. Prices as we go to press are:—Marconi Ordinary, £4 11s. 3d.; Marconi Preference, £3 15s.; American Marconi, £1 9s.; Canadian Marconi, 12s. 9d.; Spanish and General, 14s.; Marconi International Marine, £3 10s.

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Personal Notes

Decorated.

We are pleased to learn that Warrant Telegraphist Allan Anderson, D.S.O., D.S.M., has received two decorations and has been twice mentioned in dispatches for service whilst engaged in wireless duties.

Whilst still a Chief Petty Officer at the Scarborough Wireless Station he was commended by Admiral Sir A. M. Farquhar, K.C.B., C.V.O., for ingenuity displayed in devising a " quick method " of working certain codes.

Presentation.

On December 30th last the managing director of the Marconi International Marine Communication Company, Limited, presented on behalf of Lloyd's a bronze medal and certificate to Operator W. C. Bowey for meritorious conduct in rendering valuable assistance to the captain of the s.s. *Beaumaris* at the time when she was torpedoed by an enemy submarine. A full description of this incident was published in the Personal Notes of the August number of The Wireless World for 1918.

After personally congratulating Mr. Bowey, Mr. Isaacs said that the presentation ceremony had been delayed owing to his (Mr. Bowey's) absence, but he now had great pleasure in presenting the medal and certificate. Mr. Bowey had worthily upheld the best traditions of the service. After dwelling on the pluck displayed by the brave operator, Mr. Isaacs said that it had been decided by the directors to award Mr. Bowey, as a mark of appreciation, the sum of £50, in addition to the monetary grant already given by the Merchant Ships Gratuity Committee. The ceremony concluded by individual congratulations from all the officials who were present.

Wireless Telegraphists Celebrate the Armistice.

A correspondent from the Admiralty Wireless Station at Murcar, Aberdeen, sends us an interesting account of a dinner given to celebrate the defeat of the Hun. The chair was taken by Senior Petty Officer W. Pettengill, in the absence of the Commanding Officer, Lieut. W. J. Picken, R.N.V.R., and a number of operators were present.

The usual toasts and speeches were followed by a musical programme. Among the performers were P.O.'s Davis, Baker, Condon, Maltby, Barrow, Wellington and White Taylor, the last named being responsible for the arrangements.

Institute of Electrical Engineers.

Mr. J. C. Hawkhead, joint author with Mr. H. M. Dowsett of the well-known *Handbook of Technical Instruction for Wireless Telegraphists*, has recently been elected an Associate Member of the Institute of Electrical Engineers.

Scandinavian Associations of Wireless Telegraphists.

We learn from Copenhagen that the Skandinavisk Radiotelegrafist Forening of 1917, Copenhagen, has now succeeded in establishing close relationship with the two already existing Norwegian Associations of Wireless Telegraphists. All these Associations work in conjunction with one another, and on formation of the contemplated Swedish operators' union it is hoped that a " Skandinavisk Radiotele- " grafist Union " may be created.

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LIEUT. BASIL COOK, R.E.

OBITUARY.

We regret to learn of the death of LIEUTENANT BASIL EGERTON COOK, R.E., who fell a victim to pneumonia following an attack of influenza. Lieutenant Cook joined the Royal Engineers as a sapper in 1916, and proceeded to France, where he obtained his commission as a Wireless Officer, and went through the Battle of the Somme. He was invalided with shell shock and, until the time of his death, employed on home service.

FLIGHT CADET JOHN MASHEDER, of St. Annes-on-Sea, Lancashire, was killed in an aeroplane accident in Egypt on September 19th, 1918. He was accepted in the Wireless Branch of the R.F.C. in February, 1917.

Much sympathy is felt with Mr. and Mrs. W. C. Coleman, of 58, Elers Road, West Ealing, whose eldest son, CHARLES JAMES BRUCE COLEMAN, 66th Wing, R.A.F., died on October 27th, 1918, whilst on active service in Italy, and was buried with full military honours at Taranto. He joined the R.N.A.S. in January, 1917, and proceeded to Italy on November 4th of that year, on special service.

The accompanying illustration shows the last resting place, at Bagdad, of the late CAPTAIN W. H. PAYNE, Deputy Manager of Amalgamated Wireless (Australasia), Ltd., whose death occurred on active service in December, 1917, and whose obituary notice we published in the May, 1918, issue.

CAPT. PAYNE'S GRAVE.

AWARD.

The Distinguished Conduct Medal has been awarded MECH. ELECT. STAFF-SERGEANT J. SMITH, R.E., of Pelaw, who, through his bravery and energies as a wireless fitter, although under great mental and physical stress at the time, kept his station in working order throughout a long siege, daily transmitting a large volume of traffic. His splendid determination and heroic endurance were beyond praise.

RESCUE.

MR. WALTER CONDON, wireless officer, Bridge of Don, Aberdeen, was fortunate in being able to save a man who had fallen into the river there. Mr. Condon did not find the work of rescue an easy one, as he had to make fast a rope round his body before going down the steep bank into the river to pull the man out. This constitutes Mr. Condon's second successful life saving and his third attempt.

MR. E. T. S. DE LACEREA.

SANK WITH HIS SHIP.

MR. E. T. S. DE LACEREA, of Société Anonyme Internationale Télégraphie sans fil, who was junior operator on board the Portuguese steamer *Brava*, lost his life when that vessel was torpedoed by the enemy. Mr. de Lacerea was born at Ponta Delgada, Azores, on January 9th, 1899, and entered the wireless service a little over a year ago. As the ship sank in four minutes Mr. de Lacerea had no chance of escape, being imprisoned in his berth by the collapse of the cabin.

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Questions & Answers

ANNOUNCEMENT

We have received a large number of inquiries this month regarding pay and prospects in the Wireless Service. As the space required to publish this information in full would cover several pages applications should be made for Conditions of Service to The Traffic Manager, The Marconi International Marine Communication Company, Ltd., Marconi House, Strand, London, W.C.2.

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules:* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (6) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

A. F. (Invergold).—With the receiver adjusted above the normal range it is sometimes possible to hear signals from stations working on very long waves, even though it is impossible to reach a state of resonance. This, however, in no wise affects the validity of the general statement made by the author of the article you mention.

D. S. (Rhyl).—We are not yet in possession of any information as regards the official attitude towards amateur wireless telegraphy. On receiving such information we shall immediately make it public in the columns of THE WIRELESS WORLD.

M. M. H. (Salisbury).—(1) As regards the actual telegraphy, technology and knowledge of regulations, it is possible to prepare for the Postmaster-General's Examination by home study. In order to obtain the certificate a candidate must pass in actual fault tracing on apparatus on which practice is necessary. (2) There are no women employed as wireless operators on British ships at the present time

---

G. H. W. (Grimsby).—See announcement at the head of these columns.

CPL. S. O. B. (Basra).—(1) For particulars regarding examinations for the P.M.-G. Certificate you should apply to the Inspector of Radiotelegraphy G.P.O., London. (2) We believe that the Technical School at Plymouth has instituted a course in wireless telegraphy. (3) It would appear that you have already reached the required standard for telegraphy, and the time required for coaching in technical work would depend upon your previous knowledge. (4) Application to the above address would bring you information regarding fees. (5) See announcement at the head of these columns.

RADIO (Aberdeenshire).—(1) Refer to page 491 of the December issue of THE WIRELESS WORLD. (2) See pp. 495 same issue. (3) See announcement at the head of these columns.

N. W. C. (Harwich).—The interference which you mention may perhaps be caused by induction from nearby current-carrying cables, and in such cases is probably caused by small fluctuations of the current due to commutation. This may sometimes be eliminated by earthing one of the brushes of the machine in the case of a non-earth return. Sometimes it is necessary to re-arrange entirely the wiring of the mains, but in other cases the trouble can be eliminated by a re-arrangement of the external wiring of the receiving circuits.

G. G. B. (Liverpool).—You will find *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, a suitable work. If you require a more advanced text book, *The Principles of Electric Wave Telegraphy and Telephony*, by J. A. Fleming, will meet your requirements.

C. A. S. (France).—There is at present no postal course run by the Wireless Press, Ltd. If you refer to the advertising pages you will no doubt be able to make a suitable selection.

F. H. B. (Holyhead).—(1) No. The minimum length of service is twelve months. (2) You should apply to the Traffic Manager, the Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C.2, for conditions of service. (3) It is impossible to make any definite statement. It depends entirely upon circumstances.

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PUBLICATIONS OF

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R. J. M. (Mildenhall).—See announcement at the head of these columns.

W. J. K. (Urmston).—Your actions in this matter should be governed entirely by the kind of life you prefer—*i.e.*, on sea or shore.

J. W. (Shildon).—We understand that one or two steamship lines employ their own operators, but operators in the Marconi Company's service must be prepared to take up duty on board any ship to which they may be appointed.

W. J. C. (Troon).—You will find the answers to your queries (1), (2) and (3) in the appendices of the Postmaster-General's *Handbook for Wireless Telegraphists*, obtainable from our publishers, price 4½d., post free.

C. G. S. (Winchester).—(1) It is almost impossible to forecast post-war conditions. (2) No general statement with regard to this question is possible, as it is necessary to know the age, qualifications and health of the candidate. (3) Some form of wireless for inter-communication between airships and between airships and earth will be essential if only from the point of view of navigation. There will therefore be a demand for it, the extent of which will depend upon the magnitude of aerial navigation undertakings.

J. O. (H.M.S. *Curacoa*).—(1) The prospects in both services are good. It depends largely upon your natural bent as to which you think is the better of the two. (2) To enter the service of the Marconi Company it is necessary that you should hold the P.M.G. first-class certificate in wireless telegraphy. Applications for conditions of service and appointment should be addressed to the Traffic Manager, the Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C.2. You might make similar application to cable companies. (3) See conditions of service.

S. L. C. (Wellington).—When the height of an aerial is varied both its inductance and capacity are altered. The resultant change in wave-length is dependent upon the rate at which the capacity and inductance change as the height is increased. Since these two quantities are not directly proportional to the height, and because the rate at which the capacity is reduced may not be as great as the rate at which the inductance increases, it is impossible to solve the problem by your methods. For instance, you have not taken into consideration the fact that increasing the length of the down lead causes a slight increase in capacity. It must be borne in mind that the capacity and inductance are distributed over the whole of the aerial system, and the general form of the aerial and disposition of the down leads introduce other complications. See the *Calculation and Measurement of Inductance and Capacity*, by W. H. Nottage, B.Sc., advertised in this issue.

A. P. (Tours).—(1) and (2) See announcement at the head of these columns. (3) See Appendix V. of the Postmaster-General's *Handbook for Wireless Telegraphists*, published by H.M. Stationery Office, London, and obtainable from our publishers, price 5½d., post free.

H. J. R. (H.M.S. ——).—(1) and (2) See announcement at the head of these columns. (3) There is an extensive wireless service in Australia. The land stations are controlled by the Government, and the Mercantile Marine is equipped and operated by Amalgamated Wireless (Australasia), Ltd., 97 Clarence Street, Sydney. Similar conditions also pertain in New Zealand. The publication dealing with wireless in these colonies is *Sea, Land and Air*, published by the Wireless Press, 97 Clarence Street, Sydney. In Canada there is also an extensive wireless service, and inquiries might be addressed to the Marconi Wireless Telegraphy Company of Canada, 173 William Street, Montreal. There are also Government wireless services in the Colonies with which you might get in touch by addressing your inquiry to the respective inspectors of radiotelegraphy.

W. B. (Thetford).—(1) See announcement at the head of these columns. (2) Students accepted for the Marconi Company's school are guaranteed appointments on qualifying for the necessary certificate. This scheme, however, is at present closed down. The period of waiting after your name has been placed on the waiting list is dependent entirely upon the demand. (3) See "Operators' Notes," December issue of THE WIRELESS WORLD. (4) See Appendix V. of Postmaster-General's *Handbook for Wireless Telegraphists*.

"SAFE SIDE" (Beeston).—If you refer to the list of advertisers you will no doubt be able to make a suitable selection.

G. S. (H.M.S. ——).—See answer to R. J. M. (Mildenhall).

S. D. B. (H.M.S. ——).—See announcement at the head of these columns. (2) The activities of a number of companies have been curtailed during the war. The majority of British ships equipped with wireless are operated by the Marconi Company. (3) The cost of a kit is dependent upon the amount of underclothing, etc., already possessed and the tastes of the individual as regards quality. An inquiry from your tailor might bring you the required information. Prior to the issue of the Mercantile Marine Uniform Order the average cost of uniform was from £10 to £12.

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G K. (Johnstone).—The friend in whom you are interested certainly took a great risk in purchasing his uniform before he was accepted. The medical requirements of a private company are not necessarily the same as those required for the Army; for instance, particular stress must be laid upon any affection of the ear likely to develop through the constant wearing of telephones.

M. R. (B.E.F., France).—(1) Refer to Appendix V. of the Postmaster-General's *Handbook for Wireless Telegraph Operators*. (2) You should communicate with the Inspector of Radiotelegraphy, G.P.O., London. (3) *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, and the *Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett. (4), (5) and (6) See announcement at the head of these columns.

J. M. M. (Glasgow).—(1) See answer to M. M. H. (Salisbury). (2) See answer to J. W. (Shildon). (3a) See pp. 492 December issue of THE WIRELESS WORLD. (3b) See announcement at the head of these columns.

"AURORA."—You should refer to page 495 of the December issue of THE WIRELESS WORLD. (2) The qualifications necessary for appointment to a shore station differ from those required for an operator in the Mercantile Marine. Whether or not a man has a first-class P.M.G. certificate is not the main point in selection. This particularly applies in the case of high-power stations. (4) See announcement at the head of these columns.

RADIO (Rotherhithe) wishes to know why, on page 208 of the *Handbook of Technical Instruction*, in an illustration showing the type No. 10 crystal receiver, a multipoint switch is used for varying the inductance, and a large condenser placed in circuit, while in the secondary circuit there are only three possible variations of inductance and a very small condenser, seeing that both of the circuits have to be tuned to the same wave-length?

Answer.—When a very large inductance is placed in series with a very small condenser so as to make a periodic circuit, a very slight alteration in the value of the capacity will make a very large difference in the time period of the circuit. In the case of the receiver in question, the maximum capacity of the "billi" condenser in series with the smallest amount of inductance gives a wave-length which is slightly above that of the smallest practical amount of capacity in series with the second degree of inductance. The relation of capacity and inductance in the third degree is similar, so that one can get a continuous range of wave-lengths, from the shortest to the longest, by using the first, second or third adjustment of the inductance. In the case of the aerial circuit, however, it must be remembered that the large condenser is not in parallel with the aerial tuning inductance, but in series with it, and seeing that the total inductance of the aerial without the aerial tuning inductance is small, a large amount of inductance, graduated in steps, has to be used for tuning purposes, the aerial tuning condenser serving the purpose of making the circuit resonant to wave-lengths shorter than that of the natural frequency of the aerial.

E. T. (Bradford).—Quite impossible to answer this question. See other replies to queries on the subject of training and appointment to the Marconi service.

P. W. (Birmingham).—For full particulars, apply to the Traffic Manager, The Marconi International Marine Communication Company, Ltd., Marconi House, London, W.C.2.

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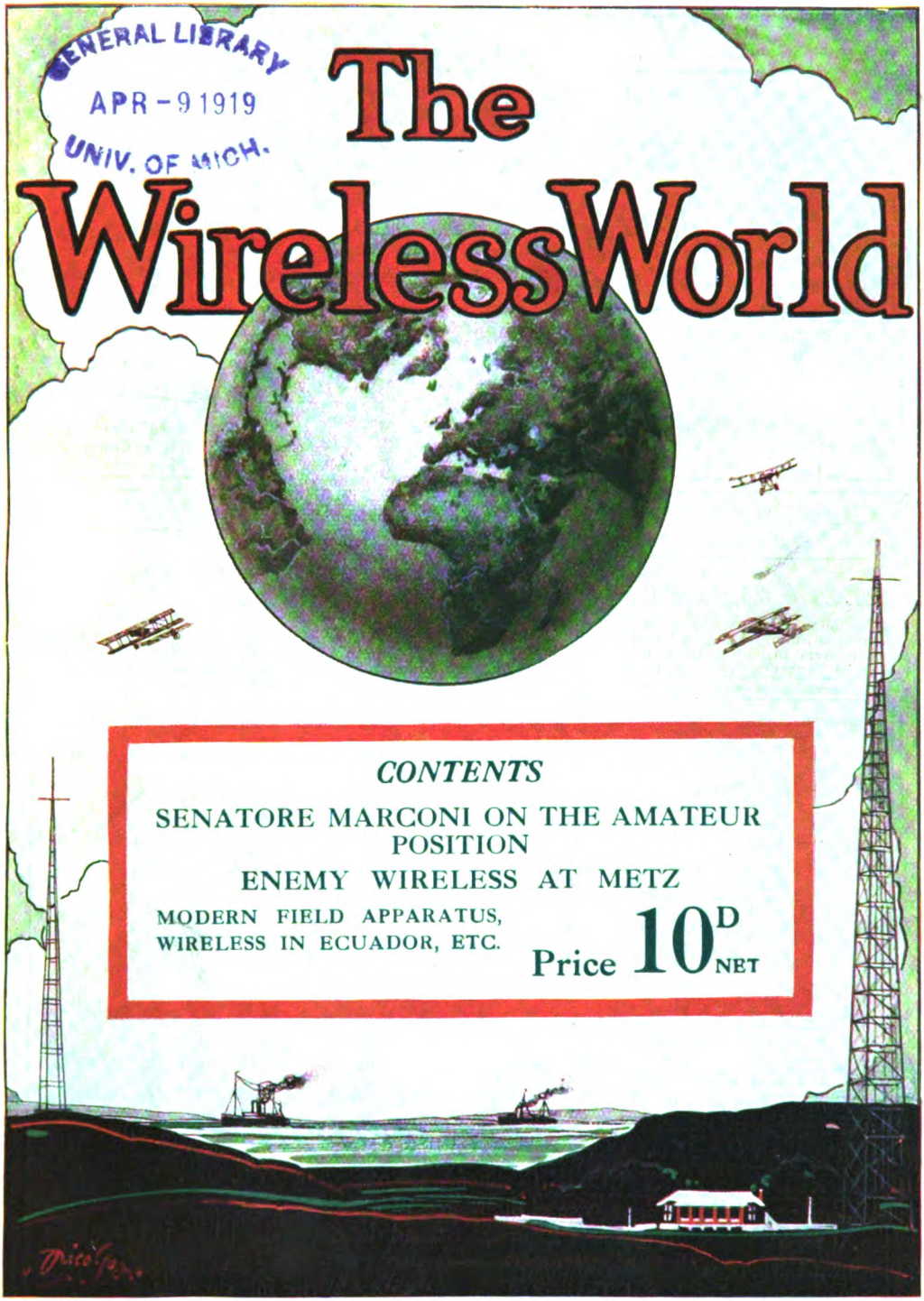

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The
WIRELESS
• WORLD •
Volume VI. No. 72. MARCH, 1919.

Equatorial Wireless

A New Station Erected at Sta. Elena, Ecuador

By P. EISLER

ECUADOR furnishes a considerable proportion of those tropical products of which the great nations of the temperate zone demand more every year, and its progressive development is therefore a matter affecting world-wide interests. Its potentialities are great and immediate, for between the Cordillera Mountains and the sea there is room for untold profusion of cocoa, coffee and cotton plantations. In Guayaquil, moreover, the Republic possesses one of the finest harbours in South America.

Shipping already abounds in the neighbouring seas; and, in view of the fact that the Panama Canal is more and more taking on the character of a great international highway, each succeeding year is destined to witness an increase in the number of keels which furrow these placid waters. Yet no wireless of any importance served their needs until, in November, 1917, the station at Santa Elena Point was opened.

The installation was inaugurated by the Marconi Company, not directly under contract, but for experimental and demonstrational purposes. It was thought that no argument could be so conclusive to Government authorities in this part of the world as a station which would shepherd the vessels plying between their ports and the rest of the world, and which would prove by an object lesson based on actual experience the value of wireless telegraphy in opening up communications in undeveloped tropical regions. The result of this experiment has been encouraging in the extreme.

The locality selected for the site of the installation is a promontory which juts abruptly out into the Pacific Ocean a little under one hundred miles away from the city of Guayaquil. Past this promontory ply the vessels of three companies performing their steamship services on a regular schedule. These are: the Pacific

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Steam Navigation Company (British), the Cia. Sud Americana de Vapores (Chilian) and the Cia. Peruana de Vapores (Peruvian). Over and above the regular lines numerous trading boats pass to and fro. All of these vessels, which carry wireless, can now maintain a regular traffic at any point along the seven hundred odd miles which stretch northward to the Isthmus, and a similar distance in the southerly direction.

The Galapagos Islands, lying out in the ocean about 600 miles to the westward, belong to the State of Ecuador; and it is hoped that communication will, through this wireless installation, be eventually maintained between this important group and the Republic which owns them. So far as the islands themselves are concerned, not merely are they remarkable for a distinctive flora and fauna, but—lying as they do on an ocean highway in the direct line from Panama to Australia and New Zealand—cannot but ere long assume that importance which must inevitably attach to a group so situated, enjoying in addition, as they do, the blessings of a perfect climate and fruitful soil.

The wireless gear was conveyed to Guayaquil and thence embarked on sailing

(*Photo by H. F. Simmons.*

AN OLD DUG-OUT RENDERED SEAWORTHY BY BALSA LOGS.

boats, locally known as *Balandras*, which ply along the seaboard here, engaged for the most part in the conveyance of salt from Sta. Elena to Guayaquil. The greater number of the balandras, as shown in our illustration on page 651, are fitted as cutters; although some of the larger craft, intended for more extensive voyages, have been schooner-rigged. From these sailing boats the material was landed on rafts (one of which figures in our illustration) constructed from a wood indigenous to these parts and known as *Balsa*. This timber is so light that a very substantial beam can be handled by a single man with great ease, and the Ecuadorians make extensive use of it for the purposes of flotation. In the case of the canoe utilised for landing our personal effects, which forms the subject of our illustration on this page, it will be noticed that the little craft, originally dug out from the trunk of a tree, had been rendered seaworthy by strapping a log of balsa to the side. The floating power of this light timber is made permanent use of at Guayaquil. Here we have a port 2½ miles long with a fine stretch of quays extending for over a mile and a half; and, as there are few piers for this great frontage, rafts of balsa wood have been put together to form a series of floating jetties, which cope adequately with the rise and fall of a tide averaging about 10 feet.

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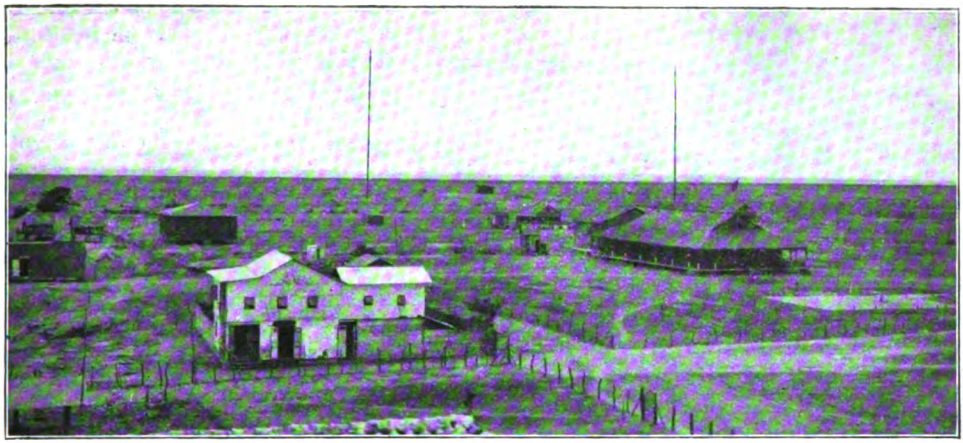
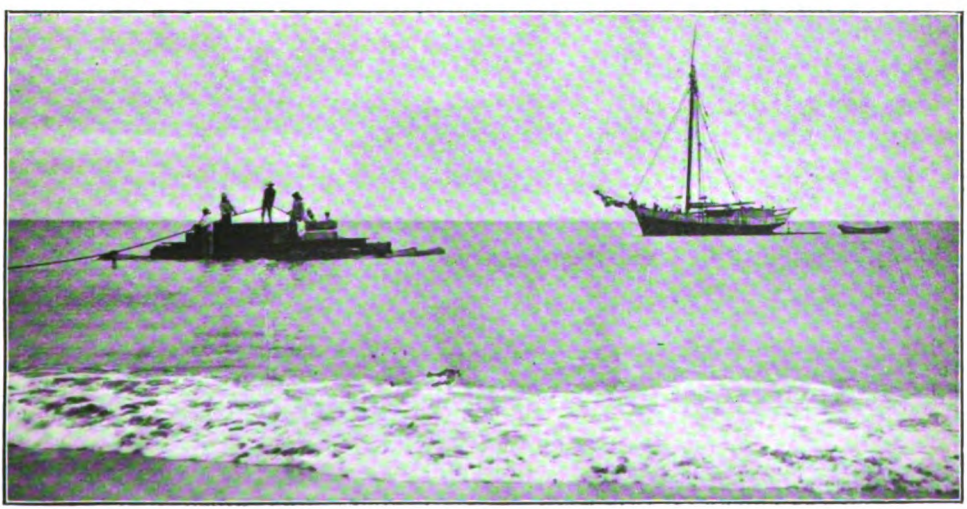


[*Photo by H. F. Simmons.*

GENERAL VIEW OF STA. ELENA STATION WITH WIRELESS STATION IN DISTANCE. THE LARGE BUNGALOW TO THE RIGHT IS THE CABLE STAFF QUARTERS.

The soil with which we had to deal is sandy, and in close proximity to the sea, so that we encountered no difficulties in making good "earths." Our tubular masts were erected in stages of 10 ft., after a fashion indicated by our three illustrations. The lattice topmast, 40 ft. in length, was hoisted into position by a pair of sheer legs. Then three 10-ft. sections of tubular mast were bolted together around this topmast, leaving 10 ft. projecting. After this, before each 10-ft. section to the tubular mast was put into position, the topmast was raised 10 ft. to correspond. In order to execute this series of manœuvres, a moving cage was provided for the men to work on, as indicated in Fig. 1. The raising of the topmast was effected by utilising a steel rope passing through a sheave in the heel of the topmast itself and carried out to a winch. Thus the construction proceeded from stage to stage, until we had attained the desired height. Fig. 3 shows the men going aloft to work in the cage, at one of the later stages.



[*Photo by H. F. Simmons.*

LANDING GEAR FROM A BALANDRA.

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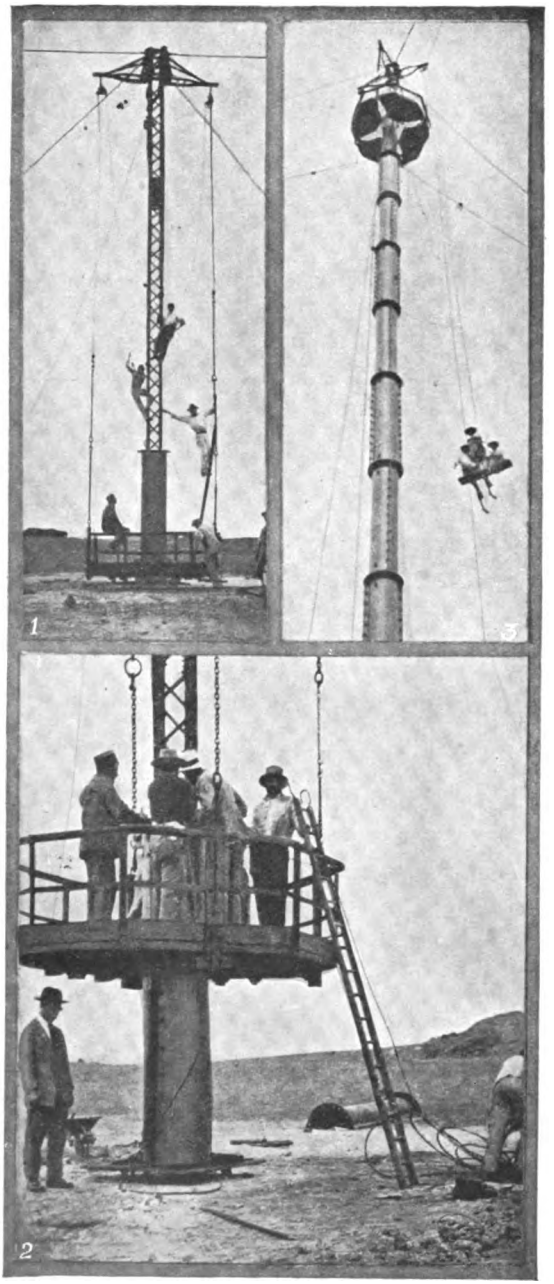
At Sta. Elena the height of our two masts runs to 260 ft. and they are placed 600 ft. apart. The power of the installation amounts to 5 kw. and radio-telegraphic operating is conducted on wave-lengths of 600, 1,000 and 2,000 metres. The engines are of 10 h.p. and driven by petrol, which is obtainable at quite reasonable rates from the neighbouring Peruvian oil fields. Ere long it may be possible to secure all that is required from the immediate neighbourhood, which is itself petroliferous and contains a number of surface wells already worked by the local inhabitants. The illustration on the opposite page gives a general view of the wireless machinery, and the installation has been equipped with receivers of the latest magnifying-valve type, capable of reception up to 4,000 metre waves.



[Photo by H. F. Simmons.

RAISING THE AERIAL MASTS: (1) THE FIRST STAGE; (2) THE LOWER SECTION WITH "MOVING CAGE"; (3) MEN BEING HOISTED INTO THE CAGE

The country which lies between Sta. Elena Point and Guayaquil is thickly wooded, with tangled tropical vegetation, and communication overland can only be maintained by means of a rough track through the virgin jungle, available for motor-cars during the dry season of the year; all through the rest of the twelve months communication is possible solely by sea.

The climate of the two places differs considerably, that of the great seaport being hot and oppressive, whilst Sta. Elena's temperature is modified by prevalent cooling breezes from the south-west. This advantage the latter owes partly to its situation with regard to the sea, and partly to the fact that it lies at the tail end of the great Humbolt current. These superior climatic conditions have caused the little seaside village to be extensively used as a watering place, or *Balneario*, by Guayaquil citizens, many of whom own the unpretentious bungalows which may be seen dotted along the sea front.

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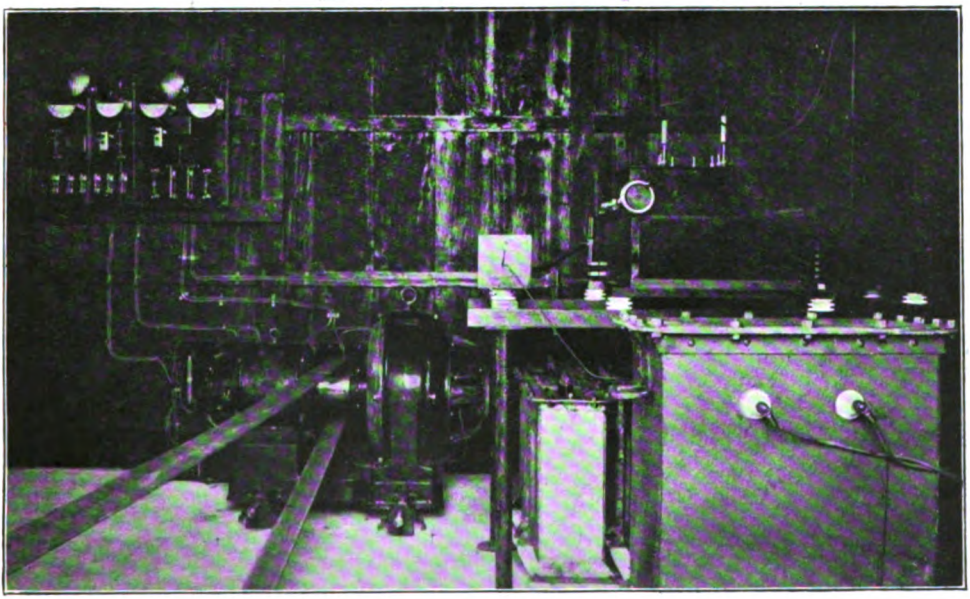
The first wireless telegraph station ever established in Ecuador was installed in 1913 at Guayaquil by Señor Don George Chambers Vivero, Captain of the Port. It was erected on his private initiative and at his own expense, for the purpose of communicating with vessels navigating in the Guayaquil river. Through its intermediary this enterprising and energetic official is able to maintain touch with the newly-erected station at Sta. Elena. The instruments of this miniature installation are worked by an Ecuadorian operator, who manages the communications in a thoroughly satisfactory manner. The technical proficiency requisite for wireless operating is well within the natural capacity of the citizens of the Republic, despite the fact that the average education prevalent within its borders does not attain so high a level as could be desired.

An eloquent object-lesson in the importance of wireless for opening up communication in relatively undeveloped countries such as this, is furnished by the inter-relations between Quito, the capital of the Republic, and Guayaquil, its principal port and chief commercial centre. The two cities are separated by about a distance of 200 miles, which is spanned by a telegraph wire. Yet, despite the importance of maintaining constant intercourse between the two most important cities of the State, telegraphic communication is not infrequently interrupted for days together. This constant interruption is owed to a multiplicity of causes, some natural, some human. Probably the most serious destruction is due to the agency of heavy rains, whose tropical violence, during certain seasons, uproots considerable tracts of the line. Then, too, the mountain folk find telegraph wire of considerable utility to them in various ways, and do not hesitate to help themselves to State property irrespective of consequences. The net result is that the maintenance of this vital line of communication causes a perennial loss, which I have heard computed by competent authorities at no less than £15,000–£20,000 per annum. Indeed, it has been stated in my hearing that, so soon as wireless communication between these two centres has been opened, the present wired lines will be allowed to fall into complete disuse.



[*Photo by H. F. Simmons.*

CORNER OF ENGINE ROOM, SHOWING TRANSMITTING APPARATUS

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PERSONALITIES IN THE WIRELESS WORLD

CAPITAIN de GENIE BRÉNOT

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THE subject of our notice this month was born at Ruoms, in the Department of the Ardèche, on September 19th, 1880. Educated first at the Ecole Polytechnique and at the Ecole d'Application of Fontainebleau, he quitted the latter establishment in 1903, and was granted a commission as Engineer-Lieutenant in the Telegraphists' Division at Fort Mont-Valerien. In 1910 he transferred to the Central Establishment of Radiotelegraphy, and supervised the installation of wireless at most of the military stations, both permanent and mobile.

He specialised in research work, having for its subject the various types of crystal detectors (certain forms of which are due to his suggestion) and some of the results of his labours have been published by *La Lumière Electrique*. In 1908 he was entrusted with the task of representing wireless telegraphy at the International Electrical Congress at Marseilles. At this time also he collaborated with M. Blondel in various investigations into the employment of frame aerials for radiogoniometry, and high tension arcs for wireless telegraphy and telephony. In 1910 and 1911 he carried through some important experiments on the employment of wireless telegraphy in aircraft. At that time with an aeroplane carrying a crew of two, designed for a two-hour flight, messages were interchanged over a distance of 40 kilometres, the station with all its accessories weighing 25 kilograms. These experiments gained for their originator the Cross of the Legion of Honour.

Captain Brénot was, before the war, in charge of the pages devoted to wireless telegraphy and telephony in the *Revue Générale d'Electricité*, besides being head of the practical work in the advanced wireless school. In 1911 he was appointed as Technical Adviser to the Minister of the Colonies, and took over the organisation of the Colonial Systems, particularly those applying to communication between the various Colonial units. This system includes 35 installations in actual working, 25 in course of construction and 30 in contemplation. Six of those now building are high-power stations. He acted as Delegate of the Colonial Office at the International Radiotelegraphic Conference of London in 1912, at the International Time Conference of Paris (1912-1913), and at the International Safety-at-Sea Conference held in London in 1913-1914. During the war, whilst remaining in charge of French Colonial Wireless, he was appointed Head of the Radiotelegraphic Centre at Paris and of the Eiffel Tower Station.

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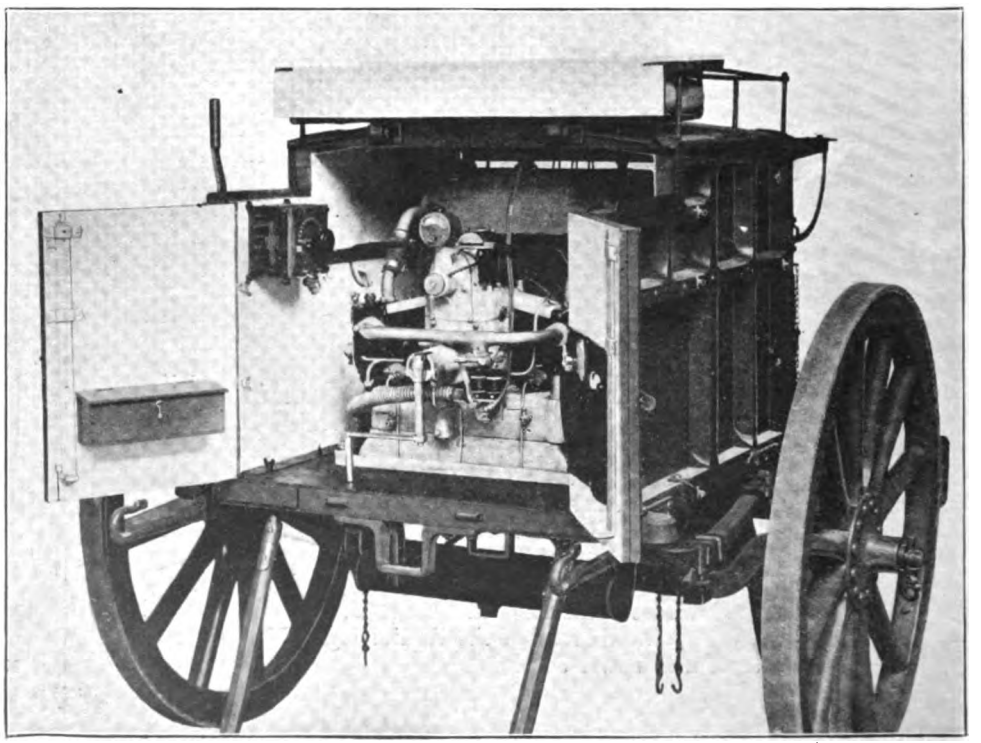
Recent Developments in Field Station Apparatus

Damped and Continuous Wave Transmitters and Receivers

WITH the removal of censorship restrictions we are now able to deal in this magazine with some of the technical details of wireless apparatus in use throughout the war. In view of the interest which has been aroused by the accounts of Army wireless work in the field, we think our readers may appreciate a description of some of the more modern field-station apparatus produced by the Marconi Company, and we therefore propose in this article to deal with the 1½-2 kw. waggon station, known as Type F2.

In the design of wireless apparatus for the field we have to take into account several important considerations which are negligible in the case of fixed stations, such as those which are used for communication with ships at sea. In the latter case portability and speed of erection are virtually unimportant, whereas, in the case of a wireless station erected in the fighting area these are primary considerations. Let us first, then, consider this particular set of apparatus from the standpoint of portability.

The station is carried by two carriages of the limber and waggon type, each



THE POWER CART. 1½–2 KW. CART SET.

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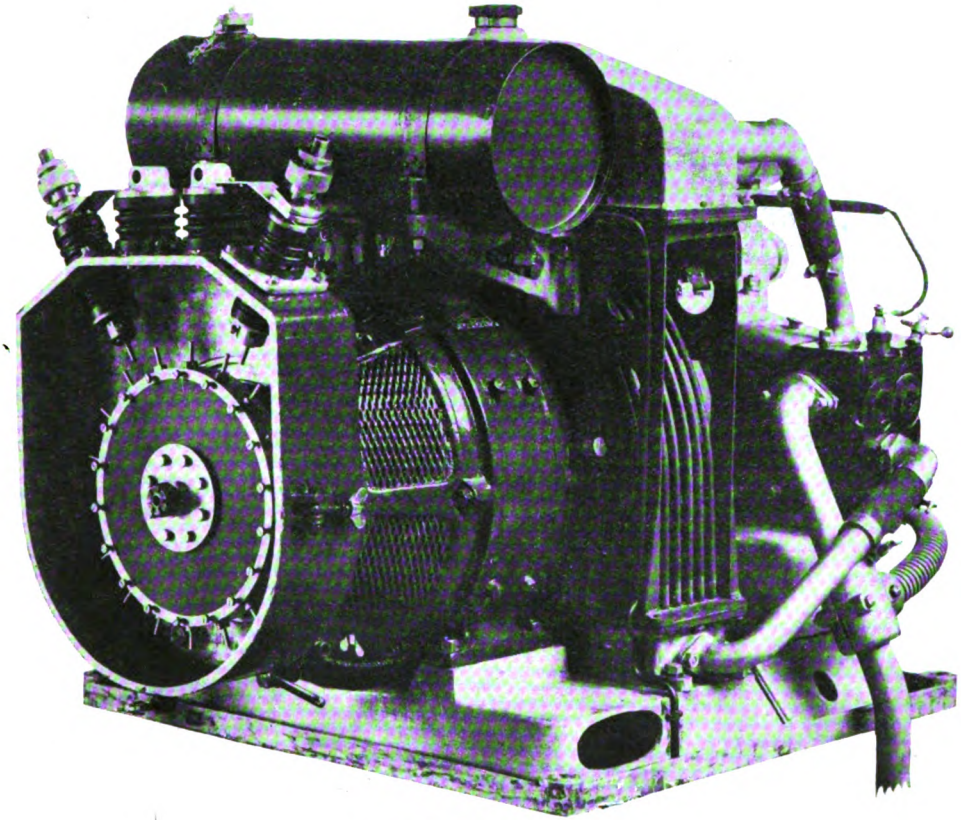

THE GENERATING SET.

carriage being drawn by four horses. The weight of each carriage complete, but without personnel, is about 29 cwt., and the total gross weight, including personnel, is in the neighbourhood of 69 cwt. The carriages, of which a good general idea can be gained from illustrations on the previous page and page 659, are solidly constructed with wheels 5 ft. in diameter and $3\frac{1}{2}$ in. tread fitted with artillery-pattern naves and bushes. The axles are solid steel forgings and are cranked 5 in. to bring the centre of gravity of the carts as low as possible. A brake is fitted to each cart, and the footboards, being removable, are so arranged as to form a seat for the operator when the station is working.

The personnel normally consists of eight men, and with a full complement the station can be erected and in action within twenty minutes of halting and can be dismantled and packed within fifteen minutes. In emergencies, however, the station can be erected and worked by a minimum of two men.

The station, when erected, is seen to possess two masts, which are of the steel tube sectional type, 70 ft. in height and supporting a horizontal antenna of the simplest possible design, allowing easy erection in any locality without the necessity of having to look for a large piece of open ground such as would be necessary to erect an umbrella antenna. The earth connection is also of the simplest possible type, and, being laid on the ground, does not interfere with the freedom of approach to the station.

The first carriage or engine cart illustrated on page 656 carries the generating set, together with the necessary fuel and oil tanks, switchboard and connectors.

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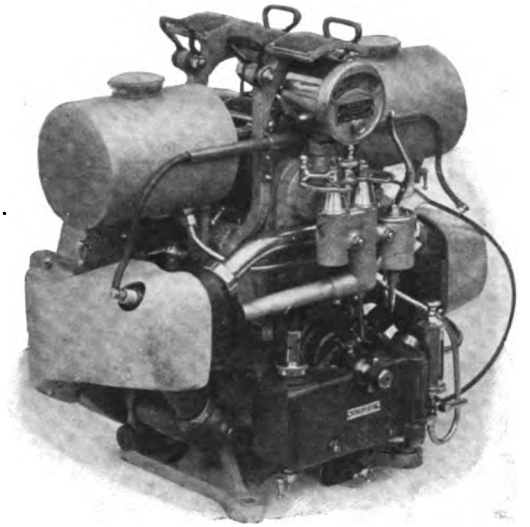
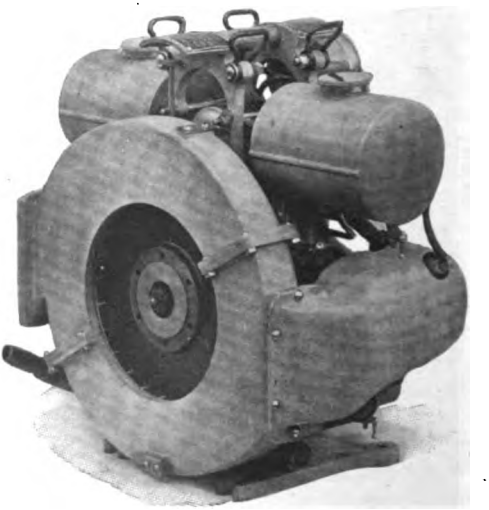


AN AIR-COOLED MOTOR.

The prime mover consists of a slow-speed petrol engine running at 1,200 revolutions per minute. Using a special aluminium alloy wherever practical and the very best materials obtainable, and by the careful design of the various component parts, the weight of the engine has been kept low while allowing a high factor of safety. To ensure steady running with a minimum of vibration a type of engine with horizontally opposed cylinders and cranks at 180° has been adopted. All moving parts are most carefully balanced, and the absence of vibration at all speeds is remarkable. All parts of the engine are made to gauge and can therefore be very easily replaced. In order to ensure efficient running under all conditions the engine has been designed to give 8 h.p., a water-cooling system being adopted. The cooling system consists of water jackets cast with the cylinders connected by suitable pipes to a large radiator, and permits cool work under the most adverse climatic conditions. A strong current of air is maintained through the radiator by means of a fan attached to the fly-wheel. The radiator is of the tubular type and is extremely simple and robust, and can be cleaned out very thoroughly should occasion require it. For use with pack stations in hot climates and in conditions where water is not readily available an air-cooled type of machine is made, and this is shown from two points of view on this page. The most modern form of high tension magneto ignition has been fitted in such a way as to ensure ready adjustment without detaching it from the engine. Lubrication has been reduced to its simplest form and rendered entirely automatic by means of a screw pump delivering to troughs into which the big ends dip, so that a supply is given as long as the engine is running and is shut off when the engine stops. The cylinders, which are 3½in. by 3½in., are bolted to the crank case and are easily detachable, while the pistons are fitted with two rings and lightened as much as possible. The gudgeon pin is a driving fit in the piston, the cylinders being protected from accidental damage by the pin by means of copper caps, pressed into the gudgeon pin-holes. The crank shaft is made from a special 3 per cent. nickel steel stamping and runs in ball bearings, and the valves, which are of nickel steel turned from the solid, are readily accessible by removing the valve covers.



THE SAME FROM ANOTHER ANGLE

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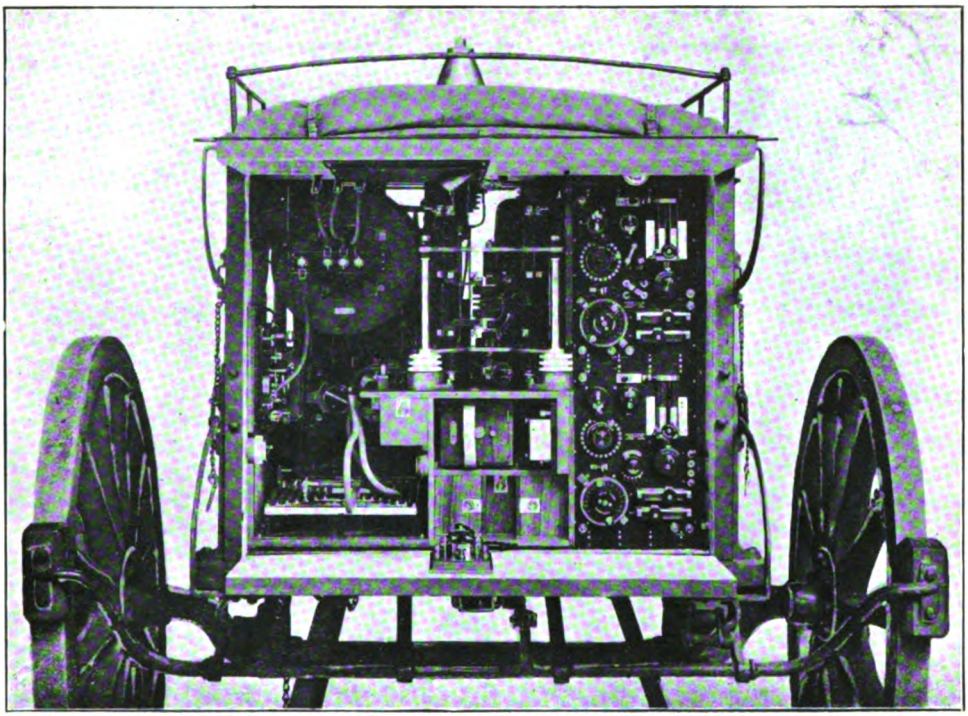

THE OPERATING CART.

Both inlet valves and exhaust valves are mechanically operated direct from the cam shaft without intermediate rockers and are interchangeable.

Directly coupled to the petrol motor is an 18-pole self-exciting generator, designed for an output of 12·5 amperes at 200 volts alternating current, and 7 amperes at 25 volts direct current, the latter being valuable for charging the accumulators used for the electric lighting of the carts and for the receivers. The end of the dynamo shaft, remote from the coupling, is prolonged sufficiently to carry the disc discharger (seen in our illustration on page 657), and a light aluminium casing extends from the end cover of the generator, which at the same time carries the fixed electrodes of the disc discharger, totally enclosing the latter and thus reducing the noise of the spark to a minimum and protecting the disc discharger from damage. The generator is driven by the engine through a flexible coupling.

Two switchboards are fitted to this set; the alternating current board, consisting of a slate panel on which is mounted a 2-pole main switch, two fuses and two guard lamps. The direct current switchboasd consists of a slate panel containing a main switch, an automatic cut in and cut out, an ammeter and a voltmeter, a fuse and two guard lamps. Connections are made between the carts by armoured leads and interchangeable plugs and sockets. The plugs are of extremely strong design, ensuring thoroughly reliable connections so arranged that it is impossible to connect the circuits inaccurately. Electric lighting is provided in both the engine and instrument carts, the current being provided by the accumulators, which are automatically charged by the dynamo whenever the engine is running.

Considering in detail the transmitting apparatus, we find that the transformer is of the closed iron circuit type, the seconding being connected through protecting chokes to the two electrodes of the discharger, across which a fixed safety spark gap is placed to prevent any excessive strain being put on the transformer or condenser

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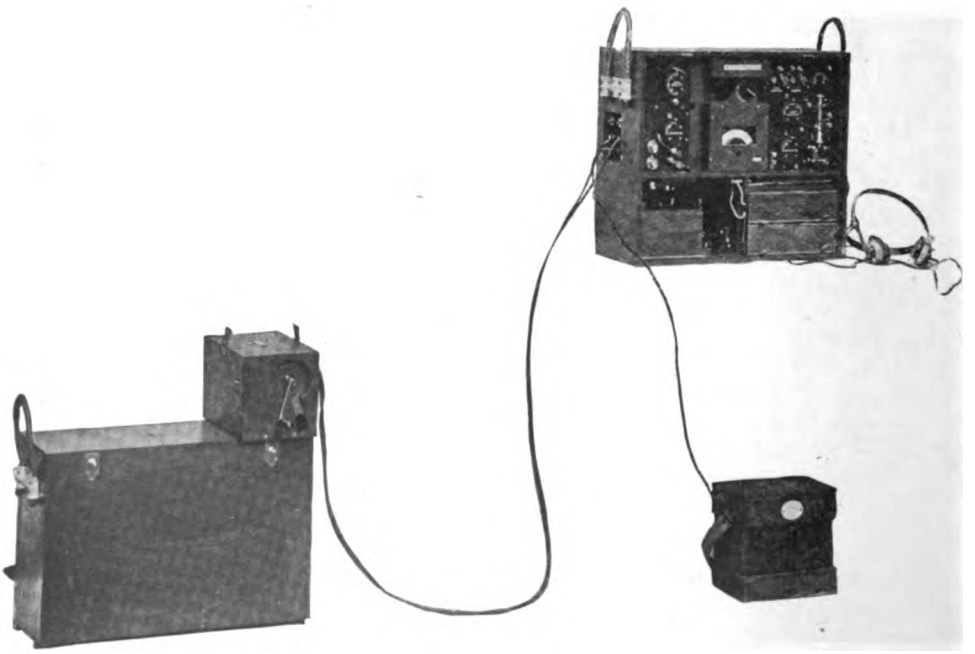
battery due to faulty adjustment of the disc. The primary high-frequency circuit consists of a condenser battery, disc discharger, primary jigger winding, operated by a 2-way switch, and fixed primary inductance, a primary tuning inductance with four adjustable tubes, and a 4-way change-tune switch. The condenser consists of 22 tubes of specially selected glass, with an electrically deposited copper coating both inside and outside each tube. The tubes are calibrated to a definite capacity, so that in the case of a breakdown a new tube may be inserted without disturbing the electrical balance of the circuit, but, being extremely strong, they are not likely to break down save in exceptional circumstances.

The jigger primary consists of four turns of a specially insulated cable of very high conductivity. A tapping is taken from the first turn of this winding and a 2-way switch is provided, by means of which either one or all four parts of the jigger primary winding and the fixed primary inductance can be connected in the oscillatory circuit. The primary tuning inductance consists of a flat spiral of silver-plated copper strip mounted in such a way that connection can be made to it at any point. The inductance winding is marked progressively and a calibration table is provided showing the wave-lengths corresponding to the various points of adjustment. Four conductors are brought through ebonite tubes to the inductance from the change-tune switch, each conductor ending in a convenient spring clip by means of which it can be attached to any point of the inductance. The change-tune switch, to which reference has been made above, is used for connecting the disc discharger to the various points on the primary tuning inductance, thus including more or less all the inductances in the primary circuit and so varying the wave-length. This switch is mechanically connected to a similar switch in the secondary circuit, so that only one movement is required to change both the primary and secondary high-frequency circuits, thus making it possible instantaneously to change the wave-length from one pre-determined value to another. The particular value of this feature lies in the fact that by pre-arrangement two stations working together can decide to change their wave-length at certain time intervals, or after certain words, and any



A PORTABLE CONTINUOUS-WAVE TRENCH SET.

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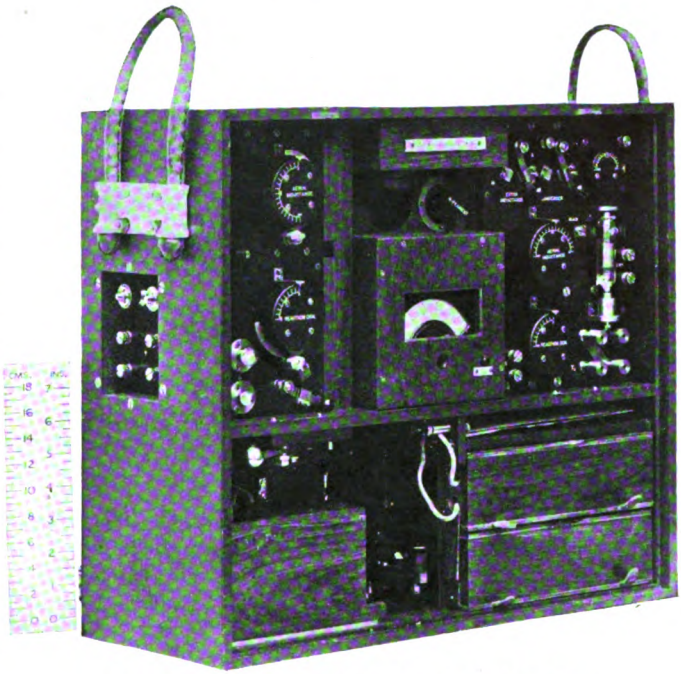
station endeavouring to intercept is thereby confused and delayed while it picks up the new wave-length. By the time it has found this latter it is possible by means of the switch to change once again to another adjustment, whereupon the intercepting station has to commence its work over again.



A CLOSER VIEW OF THE C.W. TRENCH SET.

The relative position between the fixed electrode and the disc of the disc discharger can be varied by a screw adjustment, thus ensuring that the discharge takes place at the moment when the secondary alternating current voltage is at its maximum. Once this position has been found no further adjustment is required, A blower fitted behind the discharger casing keeps up a constant circulation of air through the casing, thus carrying off the gases formed by the discharge. Connection is made from the disc discharger to the instrument cart by means of two highly insulated and protected conductors which run along the perch pole between the limber and the waggon.

The secondary or aerial circuit consists of a horizontal " T " aerial, an aerial tuning inductance, a jigger secondary and an earth connection. The jigger secondary is mounted in front of the jigger primary on a former, which can be moved towards the primary for the purpose of varying the coupling. Three conductors fitted with suitable plugs for attaching to the connection pillars are brought from one side of the change-tune switch, one of the conductors being common to two pillars on the switch. A fourth conductor connects the one end of the winding to the anchor spark gap. An aerial ammeter is connected to an inductive shunt in the aerial circuit between the jigger secondary and the earth connection, and a small sparking coil is mounted close to the anchor spark gap and can be used either for producing oscillations in the aerial when it is required to measure the wave-length of the aerial circuit or for transmitting over a distance of a few miles to save the running of the generating set.

On the receiving side two entirely separate receivers are provided. Both receivers are of similar design and are arranged for quick and easy adjustment to any wave-length within their respective ranges. The ranges of the receivers overlap one another considerably and so provide a duplication. In general design they are of the two-circuit form, being thus chosen for simplicity of operation as well as efficiency of arrangement. Two separate and independent detectors are provided with each receiver, each detector circuit consisting of a crystal, battery and potentiometer for adjusting the crystal to its most sensitive point and fitted for two pairs of high-resistance telephones which are common to both detector circuits. Arrange-

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ments are made so that both crystals may be used together for opposed crystal working, which has the advantage of reducing the noise of atmospheric disturbance to a minimum.

The general arrangement of the receivers, as well as much of the transmitting apparatus, can be seen from our illustration on page 659. With the detectors described and with a pair of similar stations working to one another the range can be guaranteed for 150 miles over a normal flat country. In most cases, however, considerably greater ranges than this may be obtained, the guaranteed figure being, of course, much less than that obtained normally. With the Marconi amplifying receivers, which are fitted when required, the guaranteed range can be at least doubled.

For both transmitting and receiving the earth connection consists of four nets of copper wire gauze, each net being provided with a string flexible connecting wire ending in a metallic plug which fits into the sockets at the corners of the instrument cart. This form of earth connection has been adopted as being a far more practical arrangement than the "capacity earths" which cover the surroundings of the station with insulated wires supported at such a height that they interfere with the approach of horses or men, besides giving shocks to those who are unfortunate enough to touch them.

Another extremely interesting and highly portable Marconi field set is shown in our illustration on pages 660 and 661. This particular set of apparatus is designed to transmit and receive continuous waves, the power for working the transmitter being provided by a hand-driven dynamo, shown attached to the box on the left-hand side of the illustration on page 660. The guaranteed range of this station is 45 miles, or double this with amplifying valve receivers. The latter apparatus is carried by two horses, the load per horse, exclusive of saddle, being approximately 160 lb. Two steel masts are provided 15 ft. high and supporting a single wire horizontal aerial 70 ft. long. The transmitting and receiving apparatus is entirely self-contained in one case and forms one-half of the instrument load, the other half consisting of two 40 ampere hour 6 volt accumulator batteries to be used for both the transmitter and receiver filaments. The high tension current for the transmitter is supplied by a hand-driven generator with an output of 20 watts at 1,500 volts. The high-tension current for the receiving valves is supplied by a small dry cell battery, two of which, one for spares and one for use, are carried in the instrument box. On page 661 a closer view is given of the instrument box. On the left the upper switch, marked in degrees, is the aerial inductance, while the lower is the reaction coil. Transmitting valves are contained in the centre of the case, while the receiver, with its detecting valve containing switches and telephone plugs, are shown on the extreme right. The remarkable compactness of the whole apparatus is admirably indicated by the measuring-rule shown at the side.

Additional Pay for Naval and Military Operators

THE bonus scheme of additional payment to Military and Naval men of both commissioned and non-commissioned rank was welcomed by the wireless men of these services equally with the other ranks and ratings. Under the new arrangement additional remuneration is paid varying in the Army from 10s. 6d. per week for a private to double that amount for a warrant officer, class 1; and in commissioned ranks from 24s. 6d. per week for 2nd lieutenants to 42s. per week for ranks over that of lieutenant-colonel.

In the Navy, boys receive 6d., ordinary seamen, 1s.; A.B.'s, 1s. 6d.; and leading seamen, 1s. 9d. per day; while petty officers, C.P.O.'s, and warrant officers receive 2s., 2s. 6d., and 3s. 6d. per day extra pay, respectively. Commissioned warrant officers and mates under the new scheme receive 4s.; sub-lieutenants, 2s.; lieutenants, 4s. 6d.; and lieutenant commanders, 5s. 6d. Captains and those of higher rank, 6s. per day additional.

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Digest of Wireless Literature

Heterodyne Reception.

It is a well-known fact that for receiving continuous waves two methods can be employed: either the incoming oscillations are split into groups (by means of some kind of interrupter—*e.g.*, a tikker), or they are made to combine with oscillations of a slightly different frequency which are usually generated at the receiving station. If the latter method (known as the heterodyne method of reception) is employed, beats are obtained, the frequency of which (given by the difference in the frequencies of the incoming and locally generated oscillations) determines the pitch of the signals. In case of the "chopper" method the pitch depends on the frequency of the interruptions.

Since the heterodyne method involves the infusion of energy from an outside source, we would naturally expect that the incoming signals will not only be rendered audible owing to the beats, but that they will also be amplified. This a priori expectation is confirmed by the results obtained in practice.

The question arises now as to the degree of amplification which can be obtained by this method. The answers given so far to this question are very contradictory. While Dr. Cohen asserts that he was able to obtain amplifications up to a hundred and more, Dr. Liebowitz, on the other hand, entertains the opinion that the maximum amplification cannot exceed 4. The present article is an attempt to throw some light on this question.

The author shows that the degree of amplification which may be expected from the application of the heterodyne will depend on the nature of the detector employed. In the case of a crystal detector two assumptions as to its rectifying action can be made.

According to one, we consider the crystal as a thermo-junction which is heated by the current due to the received signals. This would lead to the generation of an E.M.F. proportional to the square of the heating current.

According to the second assumption the detector is considered to possess a definite resistance for currents flowing in one direction and a very great or, in the ideal case, an infinite resistance in the opposite direction. Taking now the case of a pure heterodyne arrangement as shown in Fig. 1, where D is the crystal detector, T the telephone and G the local source of H.F. currents, the author discusses first the question of amplification on the former assumption.

Since the received and the local oscillations differ slightly in frequency, there will be a variable difference in phase between the two currents, the limits of variation being 0 and 180°. The resultant of the combined oscillation is shown in Fig. 2*a*. The variable amplitude will attain its maximum at the moment when the currents coincide in phase and its minimum when they oppose each other. Denoting the received current by

$$i_1 = I_1 \sin \omega_1 t$$

and the locally generated current by

$$i_2 = I_2 \sin \omega_2 t,$$

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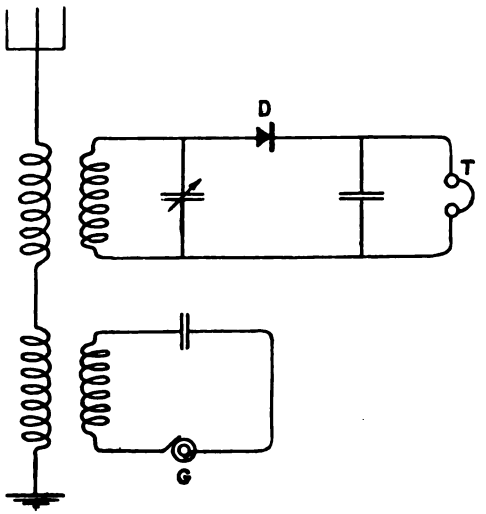

FIG. 1.

we shall see that the amplitude of the combined oscillation will vary between

$$I_1+I_2 \text{ and } I_2-I_1.$$

On our assumption, the amplitude of the current in the telephone will vary between

$$0{\cdot}5k\ (I_1+I_2)^2 \text{ and } 0{\cdot}5k\ (I_2-I_1)^2,$$

where k is a constant depending on the nature of the detector and the impedence of the telephone. (The factor 0·5 is the well-known ratio of the mean value of the squares of the instantaneous values and the square of the amplitude.)

The curve of the telephone current is shown on Fig. 2*b*, and it will be seen that it is equivalent to a steady current on which is superimposed an A.C. with an amplitude given by,

$$\tfrac{1}{2}\ [0{\cdot}5k\ (I_1+I_2)^2-0{\cdot}5k\ (I_2-I_1)^2]=kI_1I_2 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If heterodyne is not employed we have to interrupt the oscillations at some audible frequency, and we obtain a graph like the one shown on Fig. 3*a*, where the duration of the open and closed periods is assumed to be the same. The telephone current will then be represented by the graph shown on Fig. 3*b*. This can be considered as an A.C. curve of a rectangular shape and with an amplitude

$$\tfrac{1}{2}\times 0{\cdot}5\ .\ kI_1^2=\tfrac{1}{4}\ kI_1^2.$$

Our curve can be analysed by the usual methods into a fundamental sine wave, which determines the pitch of the note, and harmonics, on which the character of the note will depend. The amplitude of the fundamental wave is obtained from the amplitude of the rectangular wave by multiplying the latter with $\frac{4}{\pi}$. Therefore for our case, we shall have :

$$\tfrac{1}{4}\ kI_1^2\times\frac{4}{\pi}=\frac{kI_1^2}{\pi}.$$

Assuming that the sounds produced by two currents can be compared by the comparison of their fundamental waves, we obtain :

$$\frac{\text{Telephone current with heterodyne}}{\text{Telephone current without heterodyne}}=\frac{kI_1I_2}{k\frac{I_1^2}{\pi}}=\pi\,\frac{I_2}{I_1}. \quad . \quad . \quad . \quad (2)$$

Next, the ratio of amplification is worked out on the second assumption made above with respect to the detector.

With an absolutely rectifying detector we shall obviously have a curve similar to the one shown on Fig. 2*a*, with this difference, however, that the lower part will be chopped off (Fig. 4*a*). The amplitude will vary again between

$$I_1+I_2 \text{ and } I_2-I_1.$$

The mean values of the current will vary between

$$\frac{2}{\pi}\ (I_1+I_2) \text{ and } \frac{2}{\pi}\ (I_2-I_1).$$

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Taking into account that the current flows only during half the time, we obtain a variation between

$$\frac{I_1+I_2}{\pi} \text{ and } \frac{I_2-I_1}{\pi}.$$

The mean value of amplitude of the audio current will then be given by:

$$\tfrac{1}{2}\times\left[\frac{I_1+I_2}{\pi}-\frac{I_2-I_1}{\pi}\right]=\frac{I_1}{\pi} \quad . \quad . \quad (3)$$

Assuming that the curve which can be thus obtained is approximately a sine curve,* we may consider the last expression as giving a measure of the audio current when heterodyne is applied.

Without heterodyne we would obtain the graph shown on Fig. 4*b*. Reasoning in the same way as above, we shall find that the amplitude of the rectangular curve is given by

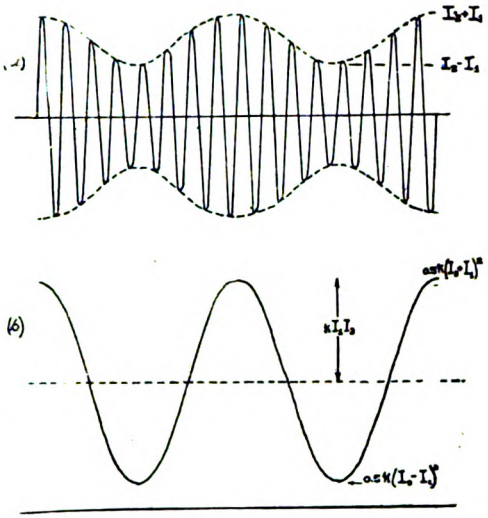

FIG. 2.

$$\tfrac{1}{2}\times\tfrac{1}{2}\times\frac{2I_1}{\pi}=\frac{I_1}{2\pi}.$$

The amplitude of the funadmental sine wave will then be given by

$$\frac{4}{\pi}\times\frac{I_1}{2\pi}=\frac{2I_1}{\pi^2}.$$

We obtain

$$\frac{\text{Telephone current with heterodyne}}{\text{Telephone current without heterodyne}}=\frac{I_1/\pi}{2I_1/\pi^2}=\frac{\pi}{2} \quad . \quad . \quad (4)$$

Since the audio power is proportional to the square of the telephone current, we shall have :

1. Assuming that the telephone current is proportional to the square of the radio-current :

Amplification of audio power due to heterodyne

$$A_1=\pi^2\left(\frac{I_2}{I_1}\right)^2$$

A_1 will grow indefinitely with the increase of the amplitude of the locally generated current (I_2).

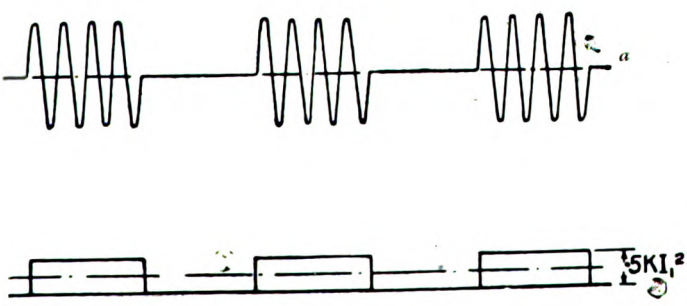

FIG. 3.

2. Assuming that the audio current is proportional linearly to the radio current, we obtain :

$$A_2=\frac{\pi^2}{4}=2{\cdot}5 \text{ (very roughly).}$$

The amplification due to

* The author does not make this assumption. He works out the exact equation of the curve and analyses it into a fundamental and harmonics.

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heterodyne is practically* independent of the amplitude of the locally generated current.

In the last section of the article the author discusses the question of the increase in the efficiency of the detector which is due to the heterodyne. He arrives at the conclusion that the importance ascribed to this factor by Dr. Liebovitz is not warranted.

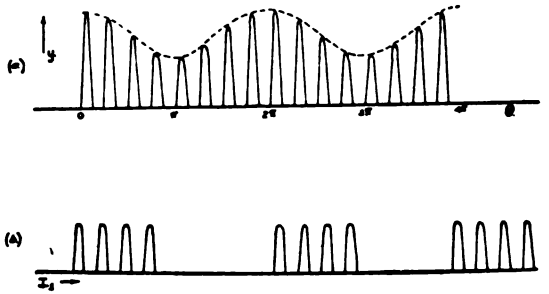

FIG. 4.

A WIDE RANGE HOT WIRE VOLTMETER.

To obtain accurate readings over a wide range with hot wire voltmeters it is usual to employ a number of instruments of similar type but different ranges. This arrangement is necessitated by the crowding of the graduations at the lower end of the scale. The author of the above article suggests that the difficulty may be overcome by joining a metal filament lamp in series with the instrument. This has the effect of opening out the lower part of the scale.

For low readings the cold resistance of the lamp is in series with the voltmeter, whilst for high readings the value of this resistance is increased by the rise in temperature. This has the effect of giving larger deflections for the former than for the latter.

By comparison of Curves I and II, Fig. 5, it will be seen that when the lamp is in use the deflection obtained for, say, 20 volts increases from 5 to 15 degrees, whilst for 220 volts the deflection is the same as when the ordinary series resistance is used. At the lower end of the scale, from 0-20 volts, the deflection is about ·75° per volt. At the upper end the deflections are only about ·4° per volt.

Errors which might be expected to arise from changes in the filament and vacuum are unimportant when a high degree of accuracy is not required.

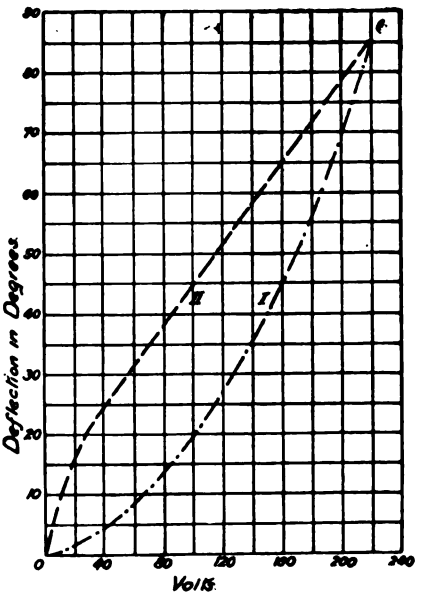

FIG. 5.

* For the reason of this qualification see the original paper, where the author shows that the amplification *does* depend on $\frac{I_2}{I_1}$, but in such a way that A_2 grows very slowly with the increase of this ratio and tends to a limit given by $\frac{\pi}{2}$.

A New Japanese Station

A LARGE wireless station is to be erected by our Japanese allies in the Prefecture of Fukushima at a cost approaching £100,000. The transmitting station will be at Hibarigahara, near Hara-Machi, and the receiving station at Hosoyacho. The new station will be in operation in two years and will communicate directly with San Francisco, a distance of roughly 4,600 miles. We wonder how many repetitions will be asked for by the San Francisco operator when he is first given the name of the t ansmitting station.

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The Amateur Position

A Plea for the Removal of Restrictions.

"I consider that the existence of a body of independent and often enthusiastic "amateurs constitutes a valuable asset towards the further development of wireless "telegraphy."—SENATORE MARCONI.

ON August 3rd, 1914, as a measure of safety, His Majesty's Government called for the immediate closing of all amateur wireless stations throughout the Kingdom. A little later all amateur apparatus was sealed up, and in the great majority of cases removed by Post Office officials for safe keeping. After a further short period a prohibition was even placed upon the publication of articles which could in any way be looked upon as encouraging the manufacture of amateur apparatus, and so, throughout the whole of the terrible world conflict, practical amateur work has been completely suppressed.

More than three months have now passed since the signature of the Armistice and still no word comes from the Government of their intentions in regard to the wireless amateur. Indeed, many people have the notion that the authorities, once having taken complete control of wireless communication, will relinquish their hold very reluctantly, and in their future activities may totally prohibit the erection and the maintenance of a wireless installation by the amateur.

Now, although the Government may have no such intention—in any case we sincerely *hope* that they have no such intention—it is fitting that we should consider the whole position of the amateur in his relation to the future of wireless telegraphy.

First of all we must bear clearly in mind that the amateur wireless movement has proved of inestimable value to the country by providing a large body of enthusiastic wireless men who have willingly and eagerly stepped into the breach to fill the need for Army, Navy, Air Force and Mercantile Marine operators. No matter where we may turn in the wireless branches of these four services we shall find numerous officers and men who gained their first knowledge of the subject through their amateur activities and private installations. These men, having given so much to their country, will regard it as their right to resume their hobby on demobilisation and on the return of peace conditions. It will not be sufficient for the Government to allow experimental work by technical institutions and schools—this alone will not be giving freedom to the experimenter. The wireless amateur has earned the right to demand that he shall be reinstated on conditions which will allow him complete freedom to carry out the work which he has so much at heart.

Of the arguments which will undoubtedly be brought forward by those who may seek to repress the amateur movement one of the first will be that of "interference." This matter has been discussed at length on many occasions. The point is covered by the broad statement that what little interference existed in the past from amateur stations was caused by improper adjustment of receivers and transmitters and poor operation. It should be quite easy to provide regulations to prevent interference without in any way hindering the genuine amateur from

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carrying out his work. A further argument will be that of lack of secrecy. To this we may answer that it is impossible to ensure entire secrecy in *any* field of communication. All wireless messages in transmission are not easily available to any who care to listen, and it is wholly unfair to the art of wireless telegraphy to foster this opinion in the public mind. The true situation is that the telephone, telegraph, cable and wireless circuits can all be tapped by those who *deliberately set out to do so.* If amateurs are not allowed to carry out their work, does the country gain any assurance that secrecy is thereby guaranteed? Deliberate spying can be carried out equally well whether such restrictions exist or not.

The amateur is not typified, as many would like the public to believe, by an irresponsible boy tinkering with "tin-can" apparatus in a back yard. As a class the amateur is better represented by a number of commissioned and non-commissioned Army, Navy and Air Force officers and men called to the colours from civilian pursuits, and engaged throughout the field of battle in wireless work of vital importance.

In our endeavour to make the position quite clear to the public we have approached no less an authority than Senatore Marconi himself, who expresses his views on the subject below. Furthermore, Dr. J. A. Fleming and Dr. W. H. Eccles —both scientists of the first rank—have kindly given us the benefit of their views.

In the United States a Bill was recently introduced with the object of giving the Government the complete monopoly of wireless communication and repressing the amateur entirely. Such a storm of protest was raised by this arbitrary move and such a volume of powerful argument was adduced that the project failed, with the result that the American amateur will be reinstated on conditions closely resembling those under which he worked in pre-war days. We trust to the good sense of the fair-minded British public to see that justice is done in this country as well.

SENATORE MARCONI'S VIEWS.

The following letter, addressed to the Editor of THE WIRELESS WORLD, *has been received from Senatore Marconi, G.C.V.O., LL.D., D.Sc., etc.*

DEAR SIR,—In response to your request that I should express my views with regard to the proposed legislation to prevent amateurs experimenting with wireless telegraphy, I wish to state that, in my opinion, to follow such a course would be a mistaken policy.

SENATORE G. MARCONI.

It should be borne in mind that in many or, perhaps, in all branches of radiotelegraphy finality has by no means been reached, and I consider that the existence of a body of independent and often enthusiastic amateurs constitutes a valuable asset towards the further development of wireless telegraphy. It is wise also to remember that had it not been for amateurs wireless telegraphy as a great world-fact might not have existed at all. In the United States, for example, a great deal of the development and progress of wireless telegraphy is due to the efforts of amateurs.

I think, therefore, that the suppression of the work of those amateurs who are interested in wireless telegraphy would be against the public interest.

I am quite aware that public service must be the first consideration, especially in view of one of the chief advantages of wireless telegraphy—viz., its power of radiating outwards from any and every centre. I feel convinced, however, that by the enactment of proper safeguards and by the adoption of suitable and improved

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devices, many of which already exist, for preventing interference with public services, any dangers arising from the efforts of amateurs would be practically eliminated. (Signed) G. MARCONI.

DR. J. A. FLEMING'S PLEA FOR THE AMATEUR.

Dr. J. A. Fleming, M.A., F.R.S., Professor of Electrical Engineering in the University of London, etc., has been associated with wireless telegraphy, as our readers know, from the earliest days of the science. He says :

To the Editor of THE WIRELESS WORLD.

SIR,—Now that the war is happily ended we ought as soon as possible to be freed from certain shackles of bureaucratic control and from any restrictions which were essential for national safety during the progress of the struggle. One of these is the permission under licence to conduct research in radiotelegraphy and telephony. At the outbreak of the war all private and University radio stations were dismantled and non-official research stopped. The question then arises—how soon will these restrictions be removed? It is a matter of common knowledge that a large part of the important inventions in connection with wireless telegraphy have been the result of amateur work and private research, and not the outcome of official brains or the handiwork of military or naval men. In fact we may say that wireless telegraphy itself in its inception was an amateur product. At the time when Senatore Marconi first made known his epoch-making inventions the official telegraphists of the General Post Office had been working for years and spending large sums of public money in trying to develop and exploit the magnetic-induction and earth-conduction methods of wireless telegraphy of very limited application, but, apart from certain pioneer work by Admiral Sir Henry Jackson, they did not succeed in utilising electro-magnetic waves for this purpose until Mr. Marconi showed them how to do it.

DR. J. A. FLEMING.

Then, again, numerous important inventions such as the crystal detectors, the oscillation valve, the three-electrode valve, the electric arc generator, the high-frequency alternator-directive radiotelegraphy beat reception, all the important uses of the thermionic detector, and much work on the study of atmospheric stray waves, has been due to private or amateur expert work, and not to official electricians in the General Post Office or the Army or Navy. If, then, full opportunities for such non-official work and research are not soon restored there is no question that the progress of the art of radiotelegraphy and telephony will be greatly hindered.

In an article published by me just eighteen years ago in *The Nineteenth Century and After* (February, 1901) entitled "Official Obstruction of Electrical Progress," I pointed out how much of all electrical discovery and invention has been due to amateur work, including in that term teachers and private investigators of all kinds.

The action of Government officials has been in most cases to hinder and not help progress. As a rule the most effective method of afflicting any department of applied science with lethargy is to constitute it a Government monopoly. The past history of telephony in this country is a striking example of the truth of the above statement. A strong effort ought therefore to be made to maintain the opportunities, under proper regulations, of private research in radiotelegraphy. If all such independent work is to be throttled by the maintenance of present inhibitions

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it is unquestionable that progress will be hindered and that inventions of great utility may never see the light.

I venture, therefore, to suggest that those interested in the scientific advance of radiotelegraphy should make their views and influence felt in preventing the entire extinction of private research work in radiotelegraphy. We do not want every schoolboy to be jogging up the æther or picking up every passing message, but we do ask that those unofficial investigators who have power to enlarge the boundaries of our knowledge shall not be locked out from an arena in which great possibilities of discovery still exist.

The fact that the British Association appointed, at my suggestion, a committee on Radiotelegraphic Research presupposes the opportunities for such work, and we do not wish to see all possibilities of it entirely destroyed.

I am, sir, etc.,

(Signed) J. A. FLEMING.

University College, London,
February, 1919.

PROFESSOR ECCLES'S VIEWS.

Professor W. H. Eccles, D.Sc., A.R.C.S., M.I.E.E., Professor of Applied Physics and Electrical Engineering at the City and Guilds of London Technical College, Finsbury, Honorary Secretary of the Physical Society, Honorary Secretary of the British Association Committee for Radiotelegraphic Investigation, etc., writes as follows:

DEAR SIR,—In response to your invitation to send you an expression of my views on the possible promotion of legislation for the limitation of experiments in wireless telegraphy, I give below what seem to me to be the main considerations bearing on the matter.

DR. W. H. ECCLES.

The paramount factor must be, of course, that of the national interest, and this has broadly two aspects. On the one hand, this new and increasingly important means of communication must be put into a position to render immediately the greatest possible public service in the affairs of peace and war; and on the other hand, improvements and invention must be stimulated to the utmost, not only for their own sake, but also in order that this country may take a high place among the nations of the world in radiotelegraphic manufactures.

There is in some degree a conflict between these two aspects, a conflict that arises out of one of the chief virtues of wireless telegraphy—namely, its broadcast character. The waves of experimental sending stations may disturb service stations while they are in the act of receiving their messages, and thus a few inconsiderate experimenters may greatly reduce the value of the most perfectly organised public service. The obvious and hasty solution of the difficulty is to limit experimental stations to a small number by law and control experiments and experimenters by the rules and regulations of a Government Department. But this simple solution would probably have as its main result the hindering of research—which is the father of invention—and the slowing down of progress in this country. This is certainly not to the national interest.

Perhaps it will be urged that research and experiment could be put into the hands of State Laboratories, and permitted to a selected few firms and persons. It is possible that such a policy might be successful for a time, but as it would doubtless have the effect of reducing the number of students of wireless telegraphy

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it would ultimately deflect ability away from this subject, and conceivably deprive wireless telegraphy of the genius that might have enriched the technology and the nation under wiser legislation.

It is unfortunate that in the simplest methods of beat reception the receiving antenna radiates while in the act of receiving; but this can be remedied by, for instance, connecting the antenna to the local oscillating circuit through a three-electrode thermionic tube, which acts as a trap and allows oscillations to pass inwards from the grid circuit to the plate circuit, and not outwards. This and other devices for the same purpose would soon be perfected, and in operation if the law were focussed mainly upon the prevention of interference.

In conclusion, I think it is not impossible to devise laws to impose such restrictions upon the emission of waves as will preclude interference with the public radio service of the future, and yet allow of liberal opportunity for the experimental study of wireless telegraphy.

Yours faithfully,
(Signed) W. ECCLES.

A CALL FOR OUR READERS' VIEWS.

We shall deal in future articles with the amateur position as it develops, and meanwhile we place our columns freely at the disposal of our readers for the expression of their views. All communications on this subject should be addressed to the Editor of THE WIRELESS WORLD.

NORTH MIDDLESEX WIRELESS CLUB.

Will former members and prospective members of this Club please communicate with the Hon. Sec., E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N.21?

Communication with the Stars

Some Interesting Speculations

COMMUNICATION with the stars is an ever fruitful source of speculation, and for this, among other reasons, considerable interest was aroused by the interview with Senatore Marconi, published in the *Daily Chronicle* recently. The interviewer, Mr. Harold Begbie, asked the famous scientist whether he thought as some do, that the waves of ether are eternal. He replied:—"Yes, I do. The messages I sent off "10 years ago have not yet reached some of the nearest stars. When they arrive "there, why should they stop? It is like the attempt to express one-third as a "decimal fraction; you can go on for ever without coming to any sign of an end. "That's what makes me hope for a very big thing in the future."

Senatore Marconi then went on to state that he hoped for communication with intelligence on other stars. Dealing with the question of the language difficulty, he said that although it was an obstacle he did not think it was insurmountable. "You see, one might get through some such message as 2 plus 2 equals 4, and go on "repeating it until an answer came back signifying yes—which would be one word. "Mathematics must be the same throughout the physical universe. By sticking "to mathematics over a number of years, one might come to speech; it's certainly "possible."

Certainly communication with the stars, if at all possible, must be effected by wireless telegraphy, and the more recent discovery of a means of magnifying signals to almost any degree places within our hands an instrument of almost infinite delicacy. When so great a scientist as Senatore Marconi talks seriously of these possibilities it behoves the sceptic to consider his position.

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German Wireless in Metz

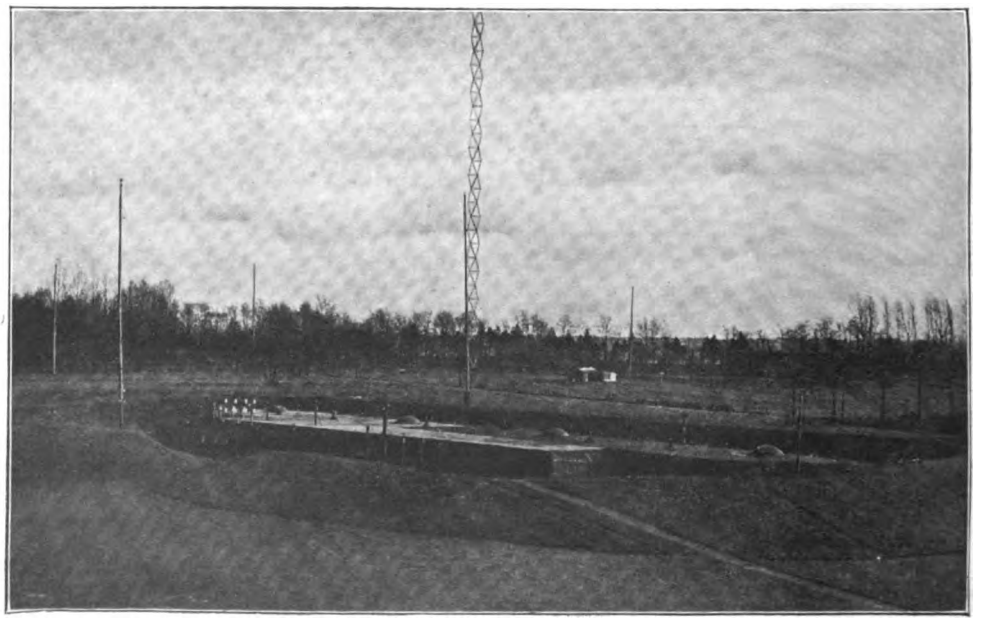
Particulars of a Captured Enemy Installation

FORTY-NINE years ago—in August 1870 to be precise—the French under Bazaine were compelled to retire into the fortress of Metz after a vain endeavour to beat off the enemy hordes. The siege which then commenced was of long duration, ending, as all the world knows, in the yielding up of the great fortress to the Germans. Thenceforward, and until the Armistice was signed in November last, Germany remained in occupation, ever increasing the strength of this wonderful circle of forts, and jealously guarding its secrets.

For a long time it had been known to the army of the Allies that a powerful wireless station was in existence in Metz, and one of the first steps taken by the French authorities on re-entry was to photograph the installation throughout. Thanks to the excellent French official news service, we are able to give this month a set of photographs which clearly indicate the chief characteristics of the station.

Our readers will see that the whole station buildings are below the level of the ground, a good general view of the situation being given below. Whilst this sunken position may afford a certain amount of protection, the existence of the station may be perceived at a distance from the masts and aerial fittings. Furthermore, we doubt whether the thickness of concrete shown in our second illustration would be sufficient protection from a modern high-power bomb, while curiously enough the sides of the station in the trench seem particularly vulnerable.

The aerial system is held aloft on two main masts and a number of shorter poles. One of these masts, as shown on page 675, is of the well-known Rendahl



[Photo: French Official.

GERMAN WIRELESS STATION AT METZ: A GENERAL VIEW.

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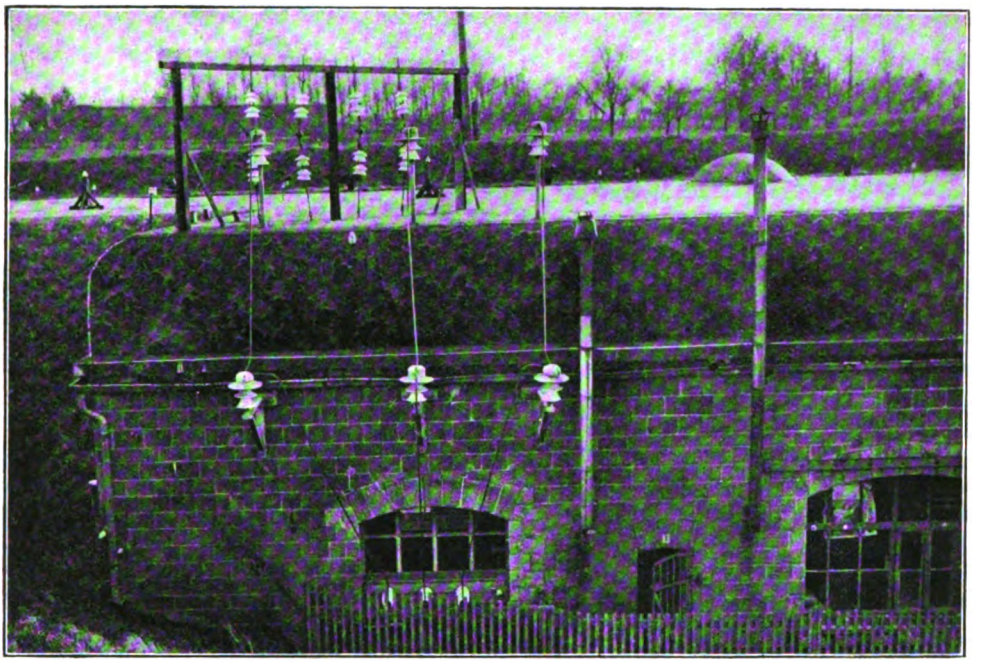

THE AERIAL LEAD IN AT METZ STATION. [*French Official Photo*

type, constructed of metallic tubes bolted together, the whole being of triangular shape and resting upon an insulated base. This type of mast, while being particularly light and strong, has the great defect that the breakage of any individual tube may bring about the immediate collapse of the whole structure. In this way a flying piece of shrapnel might bring the whole aerial system to the ground. A further peculiarity of these masts lies in the fact that the metalwork forms part of the aerial. A second mast, entirely of wood, is of the same height as the Rendahl mast—*i.e.*, 250 feet.

The aerial, as will be observed from the photograph on this page, is led into the station by three down leads supported by heavy porcelain insulators. The interior of the station seems to be quite roomy, and contains several sets of apparatus, with arrangements for transmitting and receiving both damped and continuous waves on a number of wave-lengths. The damped wave transmitter, which we have not illustrated here, possesses no point of novelty, being a standard Telefunken quenched gap installation of moderate power. The continuous wave transmitter, illustrated on page 674, is a high-power Poulsen arc, evidently manufactured by the well-known firm of C. Lorentz. Although at first glance this arc transmitter would seem to be extremely complex, closer examination reveals the fact that much of the complexity is due to wiring and auxiliary apparatus. If we examine the arc apparatus itself, we shall see that the separation of the magnet poles can be varied by means of large insulation discs, one of which can be seen at the left-hand end of the arc table. The powerful magnet windings are sectionally wound, and fit on to the magnet pole pieces, being wired in such a way that the strength of the field can be altered at will. This is necessary, as it has been found that there is a best strength of field for each particular wave-length. Connections from the various separate windings can be seen projecting along the top of the apparatus, and leads are taken to a switching device not shown. The carbon pole of the arc is slowly rotated by means of the electric motor to the left of, and just below, the insulating disc in the

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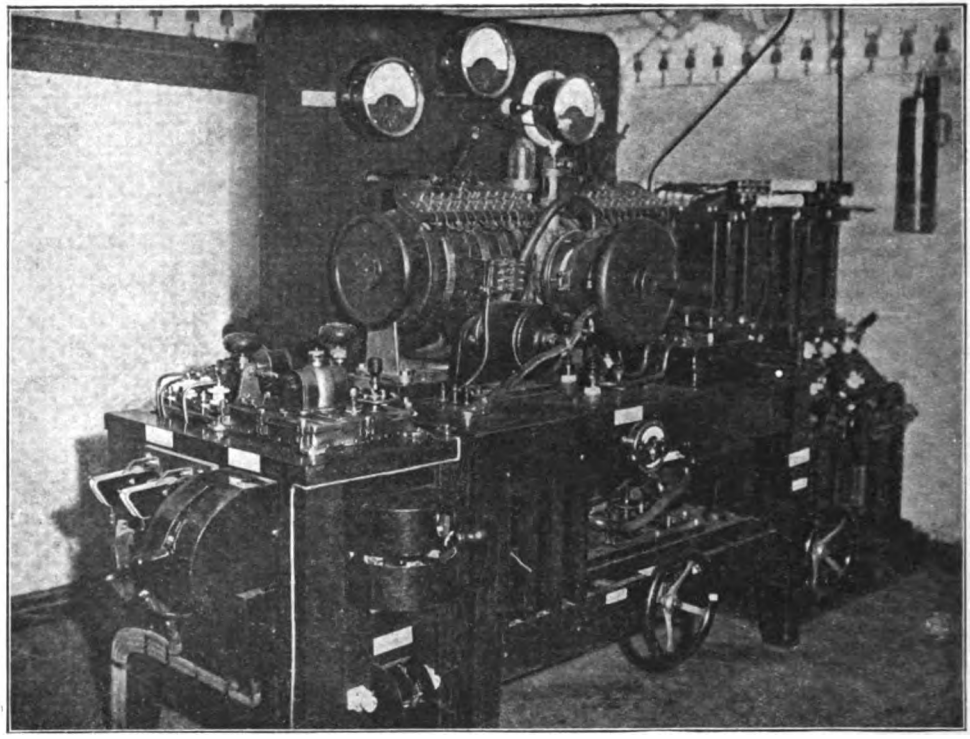
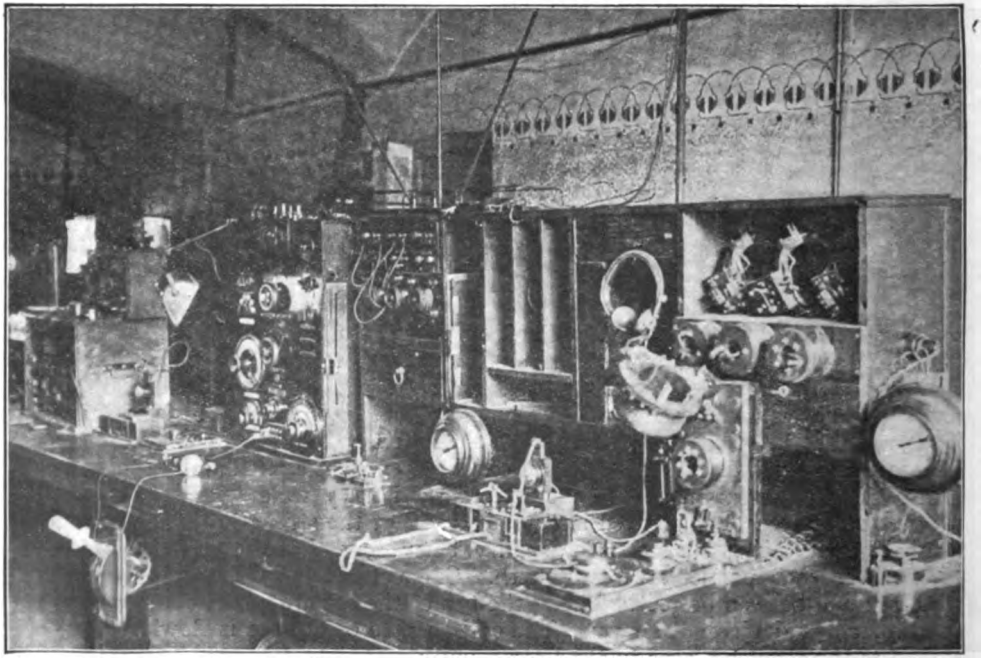


THE POULSEN ARC GENERATOR.



THE RECEIVING ROOM. [*Photos: French Official.*

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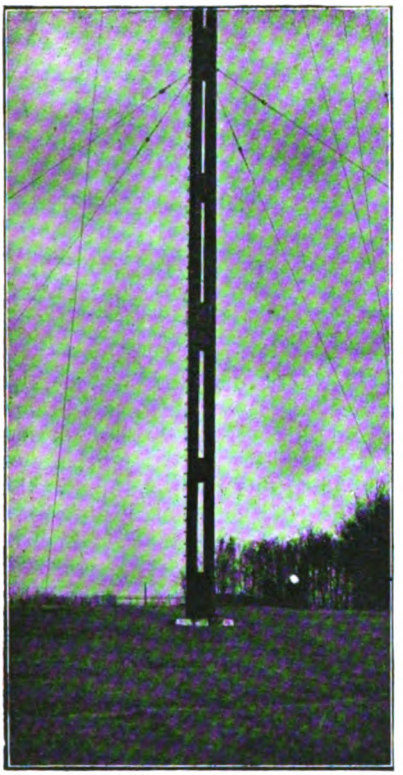


[French Official.

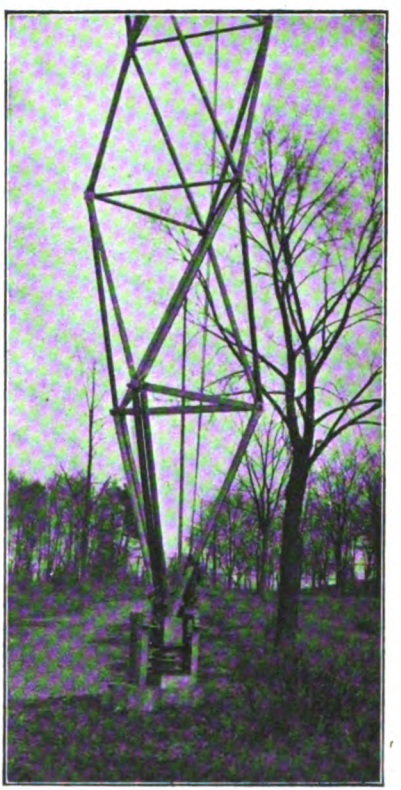
A WOODEN MAST, 250 FEET IN HEIGHT

centre of the arc apparatus. The necessary hydro-carbon atmosphere is provided by vapour of alcohol, which drips into the arc chamber from a source above.

The copper electrode is water-cooled, and one of the circulating pipes can be seen in the centre of the apparatus and also below the table. At the back of the arc will be noticed a switchboard with three indicating instruments, the two on the left being presumably an ammeter and a voltmeter respectively, while that on the right, seeing that it is mounted on a special base, is probably an aerial ammeter. The two wheels below the table operate the wave-changing device or some similar adjustment, while the table on the left of the arc, with the large switch handles, contains the transmitting relays which are operated from the manipulating key. German caution in handling this apparatus is exemplified by the fire extinguisher hanging within easy reach.

A curious feature of this station, and one which has been found in several others captured from the enemy, is evidenced in the stencilled frieze around the walls of both transmitting and receiving rooms. In the transmitting room this frieze consists of conventionalised insulators, as will be seen from the photograph of the arc apparatus. In the receiving room telephone headpieces take the place of the insulators, and perhaps form a more artistic pattern! This laborious ornamentation may be taken as typical of the German mind; certainly British operators would find something much more useful to do.

In the receiving room accommodation is provided for the reception of a wide range of wave-lengths by several operators. The lower photograph on page 674 shows the general arrangement of the main receiving table, a particular feature being the orderly pigeon holes for apparatus and papers. On the right will be seen sunk in the table a standard Telefunken receiver with a number of additional primaries and secondaries conveniently to hand. In the centre of the table a receiver of different type is fitted, utilising valves for reception.



[French Official.

A TRIANGULAR STEEL MAST.

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Notes of the Month

Airship Wireless.

One of the most dramatic stories of the use of wireless in aircraft is provided by the account of the sensational Zeppelin voyage from Jamboli, in Bulgaria, 55 miles north of Adrianople, towards German East Africa and thence back to the starting point. The distance covered was 4,560 miles, not 8,000 miles as first reported, and the whole voyage was accomplished in 96 hours. The white German troops, in the autumn of 1917, were being decimated by malaria, and General von Lettow had sent word by wireless that unless a supply of quinine reached him by a certain date he would be unable to carry on. The Zeppelin airship, L59, in charge of Captain von Butlar, was therefore despatched on her long journey. Leaving in the early hours of the morning of November 21st, 1917, the airship made her way south and 46 hours later was steering towards Khartoum at a height of 5,000 ft. At this point a wireless report from Nauen was received, saying :—" Return. East Africa occupied." As a consequence the vessel returned to Jamboli, having broken all records in long distance flying. This voyage, besides being remarkable from the scientific point of view, reveals the enormous strides which have been made in aircraft wireless to enable this message to be received from such a great distance.

A Prisoner's Handiwork.

Among the interesting exhibits at the Ruhleben Exhibition in the Central Hall, Westminster, is a beautiful model of the oil tank, *San Wilfrido*, made by the wireless operator, Mr. Ben Baxter, during the trying hours of his captivity. The *San Wilfrido* was one of the first vessels to be taken by the Germans and, as a matter of fact, was seized the day before we went to war. Mr. Baxter was one of the repatriated prisoners who returned to this country through Holland a few months before the Armistice was signed.

English Apparatus Superior.

According to the *Daily Mail*, an American engineer from the Western Electric Company recently visited England to investigate the wireless telephones of the Royal Air Force, and to make comparative tests with American instruments. He declared that the British wireless telephones are far in advance of those in use in the American Air Force. Pilots can speak to their Ground Commanders and to one another at a distance of 15 miles, and the only difficulty in communicating between machines and the ground at greater distances is the consideration of the weight of larger instruments. Between airships, for instance, it is possible to carry on a conversation at a distance of 50 miles. We were very glad to observe the publication of this statement, as the lay press has given so much publicity to the extravagant claims of American inventors. It is also a disguised tribute to the Marconi Company, who were the first in England to evolve a wireless telephone, utilising an oscillating valve as the source of the high-frequency current. This occurred some time before the war, and since the outbreak of hostilities they have contributed enormously to the progress in this art.

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CANTOR LECTURES.

On February 10th, at the Royal Society of Arts, Dr. J. A. Fleming delivered the first of three lectures on the subject of "The Scientific Problems of Electric Wave Telegraphy."

Commencing with a brief but luminous explanation of wave-motion, Dr. Fleming then considered several of the most notable theories of the ether, with special reference to its properties, and gave an account of Maxwell's Electromagnetic Theory of light, rendering the latter especially interesting by showing how Maxwell's fundamental equations are arrived at. Next were discussed Hertzian waves, their production and properties, while the interlinking of the electric and magnetic components of these waves was brought out strongly and clearly.

The latter portion of the lecture was devoted to the methods of creating electromagnetic waves, and included a description of the Goldschmidt frequency changer and the Alexanderson machine for generating H.F. alternating current. In speaking of the latter machine, Dr. Fleming pointed out the extreme accuracy of construction which is demanded, and informed his hearers that in quoting him a price for a 2-K.W. machine of this type the makers asked for £700!

Mr. Marconi's contributions to the art of producing electromagnetic waves by means of discs were also described and illustrated.

The second and third lectures of this series took place on February 17th and 24th, too late for reporting in the present issue.

WIRELESS IN THE STREETS.

During the course of a paper on "Traffic Control," read at a recent (Operating Department) Efficiency Meeting of the London General Omnibus Co., the lecturer mentioned that he looked forward to the time when wireless connection could be established between the central Control Office and every individual omnibus. However far-fetched this might appear, the audience must remember that such means of communication had been successfully used by the Manhattan (N.Y.) Police Ambulance Station. The scheme was feasible, but the necessity for training large numbers of the staff as Wireless operators would constitute the biggest objection. Wireless telephony, however, does not present such difficulty, or afford unsurmountable "snags." He was not divulging any official secret when he mentioned that he understood the war period had affected huge strides in this branch of wireless science, and that there would be no difficulty in bringing about an installation such as he prophesied.

THE COMING ECLIPSE.

Dr. Fleming, in a letter to *Nature*, refers to the fact that just before the beginning of the war arrangements had been completed for certain observations to be made on the strength of radiotelegraphic signals on the line of totality of the 1914 solar eclipse which passed through Russia. These arrangements were rendered useless by the outbreak of war. On May 29th of this year a total solar eclipse will be visible in North Brazil, and it seems very desirable, says Dr. Fleming, that any eclipse expeditions sent out to observe it should be provided with wireless telegraph apparatus and should arrange to receive and also to send signals to other stations before, during and after the passage of the moon's shadow.

It is very important to ascertain, if possible, whether there are any effects on signal strength due to the passage of the moon's shadow over a station such as accompany the diurnal passage of the earth's shadow at sunrise and sunset. Evidence obtained from long distance wireless transmission points conclusively to the close connection between it and the ionisation of the upper regions of the atmosphere.

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Valves

By Prof. B. R. OWN, G.R.I.D., T.S.F., &c., and Mr. LETIT LEAK
(Local Plumber)

Introduction.

In this little article I have tried to set down a few facts and fancies regarding the valve as used in the practice of W/T.

They are the direct result of information collected whilst acting in the capacity of W/T operator in one of Britain's aerial Dreadnoughts, although much of the advanced technical matter is the result of Mr. Letit Leak's untiring research, and to this gentleman I publicly extend my heartfelt thanks for his invaluable assistance in compiling this treatise.

Author's Note.

Through long association I had come to look upon the W/T valve as the only valve in the wide, wide world, so vividly were its advantages and merits impressed upon me at Cramwell College. I am assured by Mr. Letit Leak, however, that this is quite a fallacy. He tells me that there are H.P. and L.P. steam valves, gas valves, ball valves, and bivalves, not to mention innumerable others, besides the common or garden dot-and-dash variety.

Valves W/T may be placed in four categories:

(1) The Round Valve (deriving its name from the inventor, not from its shape).

(2) The Hard Valve (has slightly longer life than the soft valve when exposed to the tender mercies of the new operator thirsting for knowledge).

(3) The Soft Valve (so called because it is satisfied with fewer volts than the foregoing instance, and therefore does not require so many ration books).

(4) The "Q" Valve (better known as the "Hush, Hush" valve—see February issue of The Wireless World for details of results with only seven of these valves. By simple proportion it will readily be seen that 31,967 such valves would receive signals from the planet Jupiter).

All four types are much of a muchness in general principle, differing only in detail.

Taking them collectively, a valve consists of a piece of vacuum surrounded by a layer of glass. A most essential part is the small pip generally found on top of the vacuum. Its precise use has yet to be determined, but Mr. Letit Leak assures me it is a most important *point*. I do not intend to trouble my readers with smaller details, but, in passing, it is imperative to direct attention to a fundamental necessity, which valve manufacturers dare not overlook—viz., the necessity for placing some small parts within the vacuum. These are:

(1) *The Filament.*—A very fragile piece of tungsten made up of 10^{55} negative electrons. Its function is to illuminate the vacuum in order that the student may see how the other parts work.

(2) *The Grid.*—Consists of a number of holes joined together by small pieces of metal. Acts as a shade over filament to protect student's eyes.

(3) *The Sheath.*—A sheet of metal enclosing both the filament and the grid. Prevents small pieces of vacuum, dust, or dirt from falling on the filament and affecting its lighting capabilities.

At the bottom of the valve are a number of tags, generally four, although a few more or less should not worry the student. I was under the impression that these were to form a convenient method of holding the valve without making the glass dirty, but Mr. Letit Leak emphatically insists that these tags exist for the sole purpose of ensuring connection with the internal economy of the valve.

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To Test Valves.—Carefully examine, and any cracks in glass bulb should be caulked with shellac to prevent the vacuum getting out.

To Test Filament.—Grasping the valve by the tags previously referred to, bang the valve several times in rapid succession against the edge of a bench (unless an anvil is handier), when it should give forth a clear, bell-like note. Should the filament fail to glow after this test, don't waste more time with it, but get another from the stores.

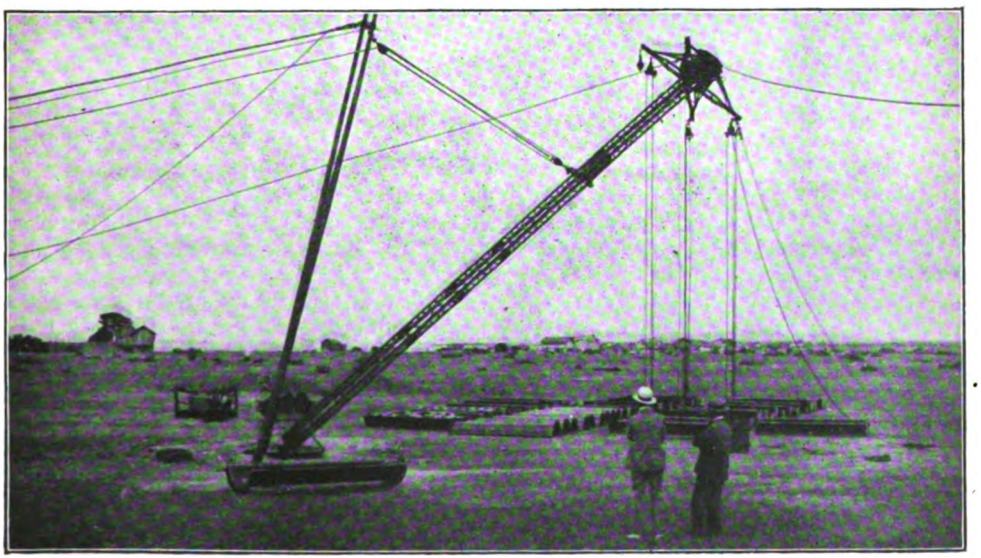
To Test H.T. Circuit.—Connect up to several thousand volts and forget the exact amount. A faint bluish glow will indicate that the H.T. has successfully run the gauntlet of the vacuum and is looping the loop between the filament and sheath, a process known technically as oscillation. Should no blue glow be detected and the valve and student still survive, throw the valve away—it is a dud.

To Test Vacuum.—Knock off small pip mentioned previously, and if vacuum is good a faint hissing noise is heard. When the hissing ceases, it denotes that Nature, which abhors a vacuum, has discovered the escape. It is not advisable to apply this test except as a last resource, owing to the extreme difficulty of re-packing the vacuum through the small hole thus made.

From the foregoing remarks the student must draw his own conclusions as to the advantages of valves. Our W/T Officer says that their tendency to disappear completely and mysteriously is not so marked as that of the carborundum crystal. He attributes this to the post-war amateur not being possessed of sufficient filthy lucre to purchase enough high tension to operate the valve, while the current price of volts is so excessive.

Finally.—Mr. Letit Leak informs me that, owing to the super-sensitive qualities of the valve as a detector, it is probable that Scotland Yard will shortly assume the entire control of the valve industry, and every detective will be fitted with seven valves. Police constables, on the other hand, will only be provided with amplifiers.

For further information read my companion volume, *Detectors for 'Tecs*, price 7s. 6d. in cloth, or 2s. 6d. paper editions.



RAISING THE LATTICE TOPMAST AT STA. ELENA WIRELESS STATION (SEE PAGE 651).

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Among the Operators

Amongst the many mischances and perils of war the total disappearance of the s.s. "Keltier," of which nothing has been heard since October 1st, 1918, must be mentioned. The operator, Mr. Andrew Craig, of Aberdeen, was born at Portlethem. He was educated at the Victoria Road Public School, afterwards attending Walker Road Continuation School. He gained his First Class P.M.G. Certificate at the Scottish Wireless College, Aberdeen, and joined the service of the Marconi Company on August 16th, 1916.

OPERATOR WALTER HENRY MILLS, who was appointed to the staff of the Marconi Company on April 29th, 1918, has died from influenza and pneumonia. He was resident in London and received his education at private schools in Dover and Penge. For some time he was employed in the engineering department of the Charing Cross, West End and City Electricity Supply Company, and entered the Marconi Company's London school as a learner on October 15th, 1917.

Colleagues who are readers will be sorry to learn of the death from pneumonia of MR. THOMAS DAVISON, late of South Shields. He was landed at Nantes from the s.s. *Cressington Court*, and died on December 29th, 1918. Mr. Davison attended evening classes at the Newcastle School of Wireless Telegraphy and was appointed to the staff of the Marconi Company on January 5th, 1916.

MR. CHARLES PILLING, who died from pneumonia on October 30th, 1918, was born at Farnworth. He was educated at Bolton Grammar School and received wireless training at the Fallowfield College. He was appointed to the operating staff of the Marconi Company on January 17th, 1915, and was attached to the s.s. *Valetta* at the time she was torpedoed.

Another victim of the influenza epidemic was OPERATOR G. L. FLANAGAN, who died on November 5th, 1918. His home was in Leicester, where he was educated at the Holy Cross Schools. He obtained his First Class Certificate at the North British Schools, Edinburgh, and joined the staff of the Marconi Company on June 29th, 1918.

Senior members of the Marconi Company's operating staff will learn with deep regret of the death from influenza and pneumonia of OPERATOR MARTIN ROHAN, who was appointed to the staff on August 2nd, 1914. Mr. Rohan was born at Stradbally, Castlegregory, Co. Kerry, and was educated at Aughacasla, N.S. He obtained his certificate at the Atlantic College, Cahirciveen, and served on board a number of well-known vessels. He was also attached to the s.s. *Vonne* when that ship was torpedoed.

OPERATOR DUNCAN MACKINTOSH died on November 4th, 1918, from influenza and malarial fever. He was born at Pityoulish, Aviemore, and was educated at the Rothiemurchus Public School, after which he entered the service of the Bank of Scotland. Mr. Mackintosh received wireless training at the North British Wireless Schools, Glasgow, and was appointed to the Marconi Company's staff on September 17th, 1917.

The operator of the s.s. *Llangorse*, MR. A. J. WALLEY, was landed at Marseilles and admitted to hospital, where he died from influenza on November 31st, 1918. Mr. Walley was a native of Burton-on-Trent, where he was educated at the Guild Street Secondary School. Formerly a telegraph clerk employed in the Midland Railway Company, he entered the Marconi Company's School on August 13th, 1917, and was appointed to the staff on January 6th, 1918.

We learn that MR. EDWARD ALLEN WALL, who was left in hospital at Sydney, N.S., suffering from influenza, died on October 31st, 1918. Formerly a student at the Birmingham Wireless School and a native of that city, Mr. Wall was educated at Grove Lane and Power Street Schools, and was appointed to the Marconi Company's staff on December 12th, 1916. He was attached to the s.s. *Pandion* when she was sunk in a collision and later was on board the s.s. *Spectator* when she was torpedoed.

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ROLL OF HONOUR.

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Our April Issue

Interesting Additions and Improvements in the New Volume

WITH our April issue we open the seventh volume of THE WIRELESS WORLD in conditions which we are glad to say permit us to introduce a number of important additions and improvements. The numerous restrictions which have been placed upon us during the war and many of the difficulties of production which have so seriously handicapped us in the past four years have now been largely removed, and with the opening of the new era of peace we hope to provide in our magazine an abundance of articles and information of great value to the amateur and professional wireless man.

The first change which our readers will observe will be in the cover design. In future we shall provide a change of cover design each month, and our readers will thus be able to gather the main feature of the contents at a glance. The arrangement of the magazine will also be greatly improved, and altogether the magazine will be produced in a more attractive form.

While the main features of our literary contents will be retained, a new and important feature will be provided in a section devoted specially to wireless in its connection with aircraft. The new series of Instructional Articles will be prepared for the benefit of those numerous readers who intend to resume their amateur activities with the removal of existing restrictions and will deal with practical amateur wireless telegraphy and the construction of apparatus. Immediately the future policy of the Government in relation to the amateur is announced articles will be published indicating the best lines for the amateur to pursue, and our Questions and Answers column will deal fully with any queries which our readers may care to submit.

Special features of the April issue will be an interesting illustrated description of the great wireless station at Poldhu, showing the latest type of apparatus installed, and a powerful article by a wireless officer describing the part played by radio-telegraphy in the last phase of the fighting in France and Belgium. Our well-known contributor, Mr. J. Scott Taggart, will provide a valuable article entitled "Practical Notes on Continuous Wave Reception," and other writers will contribute useful articles on other phases of the subject.

As announced in our February issue, the price of THE WIRELESS WORLD in the new volume will be 9d. per copy, instead of 10d., as at present, a change which we think will be much appreciated.

As it is not yet permissible to circulate any magazine on the "sale or return" principle, we would again like to emphasise the importance of placing a definite order for the magazine instead of relying on the possibility of purchasing the copies from the bookstall.

Pay for American Operators

THE United States Shipping Board has fixed the rate of pay for all Chief wireless operators and assistant operators, beginning on January 1st, 1919. The former are to receive 110 dollars a month, and the latter, 85 dollars. There are to be no bonuses and no sliding scale.

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Correspondence

To the Editor, THE WIRELESS WORLD.

Funabashi, Japan, December 19th, 1918.

DEAR SIR,—Atmospheric conditions being most favourable for wireless from October of the year to February or March next, the range of radiotelegraph communication shows a considerable increase during this period. As a consequence, the Funabashi wireless station is now receiving over an amazing distance signals sent by high-powered stations in Europe and America. While it is a fact patent to the world that the large radio-station at Nauen, Germany, rendered great services during the war instructing cruisers and U-boats, especially remarkable was the activity of the station when Germany proposed an armistice to President Wilson last month. The German station then did its utmost to arouse the world's sympathy by broadcasting one after another press messages declaring her miserable internal conditions. These messages being distinctly and regularly received at Funabashi, the miserable state of Germany was made clear to us who are five thousand miles distant from there. Another German station "O.U.I.," probably at Eilvese, working with Madrid, Spain, is picked up by us frequently. We can read easily, too, signals sent from stations "Y.N." and "I.D.O.," at Lyons, France, and Rome, Italy, respectively. The Tuckerton "N.F.F." in New Jersey, which is now under the control of the U.S. Navy, is also being heard here by day and by night, communicating with Lyons or San Diego "N.P.L.," Cal. The distance from Tuckerton, running up to seven thousand miles, is the longest we have ever attained. In view of such great development of radio-telegraphy in late years—one must admit a strong rival of the cable service in the field of international communication—the first and due consideration should be given to the erection of powerful wireless stations instead of discussing the question of laying a cable, which is costly and liable to interruption, in the deep sea.—Yours respectfully,

(Signed) K. JONEMURA
(Funabashi Wireless Station).

WE notice the following letter has been written to the Editor of *The Portsmouth Evening News* :—

"SIR,—Nearly every other town in Great Britain has a wireless society—why "not here? There are plenty of enthusiastic wireless men in Portsmouth who would "be only too glad to have a meeting place to discuss matters.

"Wireless is a very interesting subject, and there is still much to be done to "get the best out of the apparatus used. If you are a wireless man and feel that you "want to argue the point, then write to me and we will see what can be done with a "view to forming a society.

"W. G. HILL.

"106 Westfield Road, Southsea."

We shall be pleased at all times to give room in our columns to the publication of readers' views on the above or kindred subjects.

SOME INTERESTING CORRESPONDENCE.

A RECENT issue of our esteemed contemporary *The Electrical Review* contains the following letter from Mr. A. A. Campbell Swinton :—

In the interest of historical accuracy, may I protest against the suggestion contained in your article on "Wireless and the War" that Mr. Marconi, when he first arrived in this country, failed to meet with sympathy in official circles?

This is very unfair to the late Sir William Preece, then Chief Engineer to the Post Office, who received Mr. Marconi with open arms and gave him much technical

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assistance, including the use of a considerable sum of public money, which was expended in developing wireless telegraphy by numerous experiments carried out with the help of Post Office officials, including Mr. (now Sir) John Gavey.

Official sympathy with inventors is perhaps not very common, but there was certainly no cause for complaint in this particular instance.

(Signed) A. CAMPBELL SWINTON.

Westminster, January 25th, 1919.

As this letter raised a point of considerable importance, Senatore Marconi has forwarded to the editor of *The Electrical Review* the following reply :—

The Editor of "The Electrical Review" :—

SIR,—With reference to the letter of Mr. A. A. Campbell Swinton which appears in your issue of January 31st I quite agree with his statement that there is no foundation for the suggestion that when I first came to this country I failed to meet with sympathy in official circles, at any rate so far as the late Sir William Preece, Sir John Gavey and Mr. H. R. Kemp, of the General Post Office, are concerned. It is quite incorrect, however, to say that the assistance of this department "included "the use of a considerable sum of public money." This is an allegation which I have repeatedly denied, notably in evidence which I gave in 1907 before the Select Committee of the House of Commons on the Berlin Radiotelegraphic Convention of 1906, and again in 1913 before a Select Committee of the House of Commons appointed to inquire into the agreement of 1912 with the Marconi Company.

In the interests of ordinary—as well as historical—accuracy I cannot do better than to reproduce here two extracts from the aforesaid evidence. In 1907 I said :—

"If you will allow me with reference to a general idea that there is in existence "about my early relations with the General Post Office, I wish to state that I shall "always feel grateful for the encouragement they gave me and the interest they took "in my methods during those early trials. At the same time I would also like to "state, on account of a belief that there is about it, that I obtained no financial "assistance from the Post Office ; fortunately, I did not require it at that time, I "only thought it necessary and thought it desirable to interest them in what I was "doing and to show them what I could do."

And in 1913 my words were as follows :—

"I think it right to repeat what I stated before the Select Committee on the "ratification of the Radiotelegraphic Convention of Berlin, that I feel grateful to "the Post Office authorities for the encouragement they gave me and the interest "they took in my work during those early trials. I wish, however, most emphatically "to state that at no time have I ever received from the Post Office or any Govern-"ment department anything in the way of a favour which would have been in "common courtesy afforded to any scientific worker by any Government in any other "country of the world."

Neither Mr. (now Sir) John Gavey, who gave evidence before the 1907 Committee, nor Mr. (now Lord) Buxton, who was then Postmaster-General and who was a member of the Committee, said anything that could be construed as a refutal of the evidence I have reproduced above.

What I greatly regret, however, and, if I may be allowed to say so, this constituted to my mind a mistake on the part of the Post Office, is that I was practically compelled to allow my experiments in South Wales in May, 1897, to be witnessed in all their details by Professor A. Slaby, of the Charlottenburg Technical Institute and a personal friend of the Kaiser. I did not know Professor Slaby nor had I ever expressed the slightest desire to allow him to witness my experiments, but did so out of courtesy to the Post Office officials who introduced him and who made the request.

(Signed) G. MARCONI.

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The Design and Construction of Apparatus for the Wireless Transmission of Photographs

ARTICLE II.

BEFORE proceeding further, there is one point connected with the last article that requires a little more explanation. In Fig. 3 the numbering of the contacts of the two-way switch *L* was omitted, and this is now given in Fig. 8 accompanying this article. Also in the letterpress relating to Fig. 5, 2 *BA* should read 1 *BA*.

It was the writer's intention to have started in this article the construction of the machine and driving gear, but as the drawings for this are not yet completed it was decided to begin with designs for one or two of the smaller pieces of apparatus required. Although there is a lot of work entailed in the building of such a set as will be described in these articles, there is nothing very complicated in the design of the various pieces of apparatus that will call for more than an ordinary amount of mechanical skill on the part of the builder, and, indeed, should not prove more difficult than the construction of a good wireless station. The efficiency and reliable working qualities of the entire set must, however, if any accurate and serious work is to be attempted, be beyond reproach, as there are numerous pieces of apparatus all requiring fairly delicate adjustment and depending one upon the other for successful working.

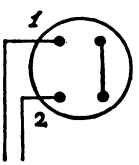

FIG. 8.

The first piece of apparatus to be taken in hand will be the contact-breaker *L*. The general arrangement of this will readily be gathered from a study of Fig. 9,

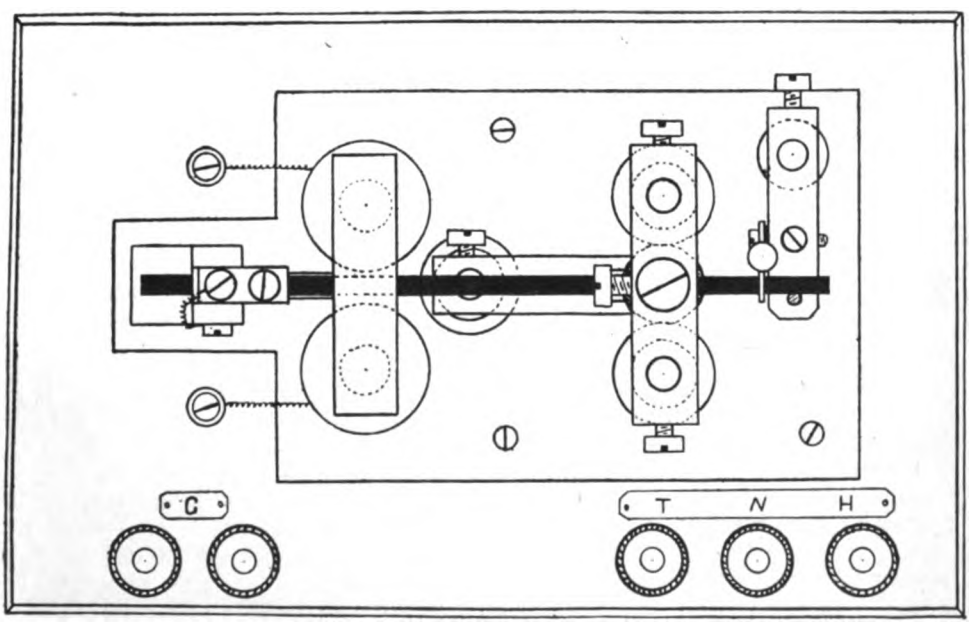

FIG. 9.

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and the construction from Figs. 11 to 24. A photograph of the complete instrument is given in Fig. 10.

The baseplate, Fig. 11, is cut from a piece of mild steel $5\frac{3}{4}$ in. by 3 in. by $\frac{3}{16}$ in. thick, and should be marked out for drilling as shown. The holes *B* are drilled $\frac{3}{8}$ in. diameter, the holes *F* are $\frac{1}{4}$ in. diameter, and the holes *D* $\frac{3}{16}$ in.

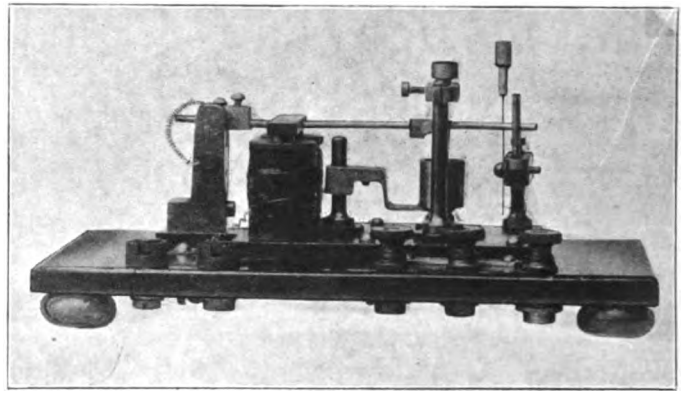

FIG. 10.

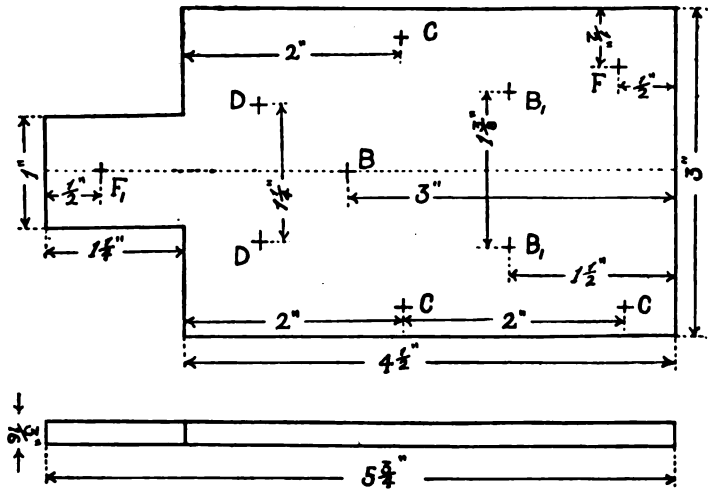

FIG. 11.

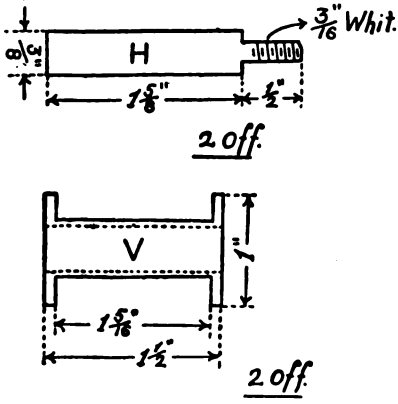

FIG. 12.

diameter. The holes marked *C* are $\frac{7}{16}$ in. from the edge of the plate, and should be drilled $\frac{5}{32}$ in. diameter. The magnet cores *H* are turned from a piece of well-annealed iron rod to the dimensions given in Fig. 12, the screwed shanks being a tight fit for the holes *D* in the baseplate. The bobbins *V*, which are 1 in. diameter and $1\frac{1}{2}$ in. long, are turned from box or other hardwood to the dimensions given in Fig. 12. The $\frac{3}{8}$-in. central hole should be a sliding fit over the iron cores *H*, and the shell turned very thin in order to get the windings as close to the core as possible.

The armature *A*, Fig. 17, consists of a piece of soft iron 2 in. long by $\frac{1}{2}$ in. wide and $\frac{3}{16}$ in. thick, and should have a $\frac{1}{8}$-in. diameter hole drilled right through the centre of the side as shown. This hole is to take a $5\frac{1}{2}$ in. length of $\frac{1}{8}$ in. diameter silver steel rod *S* which is pushed through until $1\frac{1}{2}$ in. project from one side of the armature, in which position it is secured by closing the metal over the rod by one or two dots made by means of a centre punch. The contact block *C* is of brass, and measures $\frac{9}{16}$ in. by $\frac{3}{8}$ in. by $\frac{1}{32}$ in. In order to reduce weight a recess is filed on one of the narrow edges as

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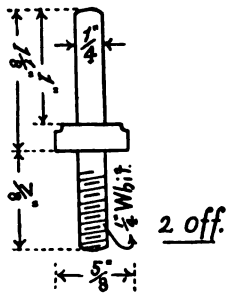

FIG. 13.

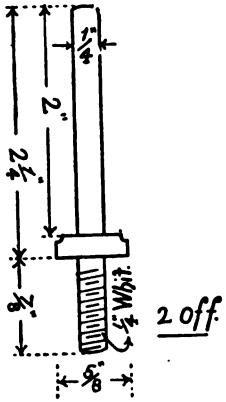

FIG. 14.

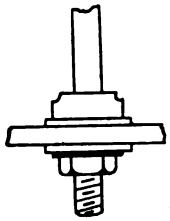

FIG. 14A.

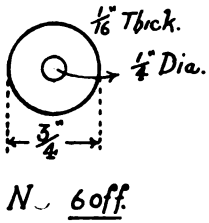

FIG. 15.

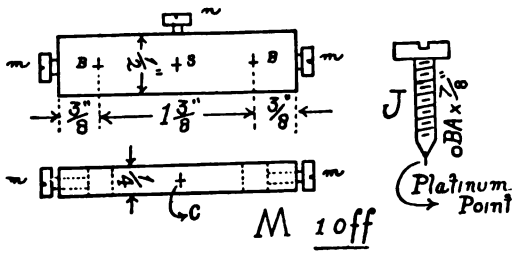

FIG. 16.

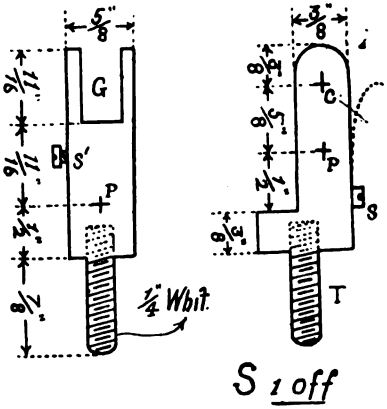

FIG. 18.

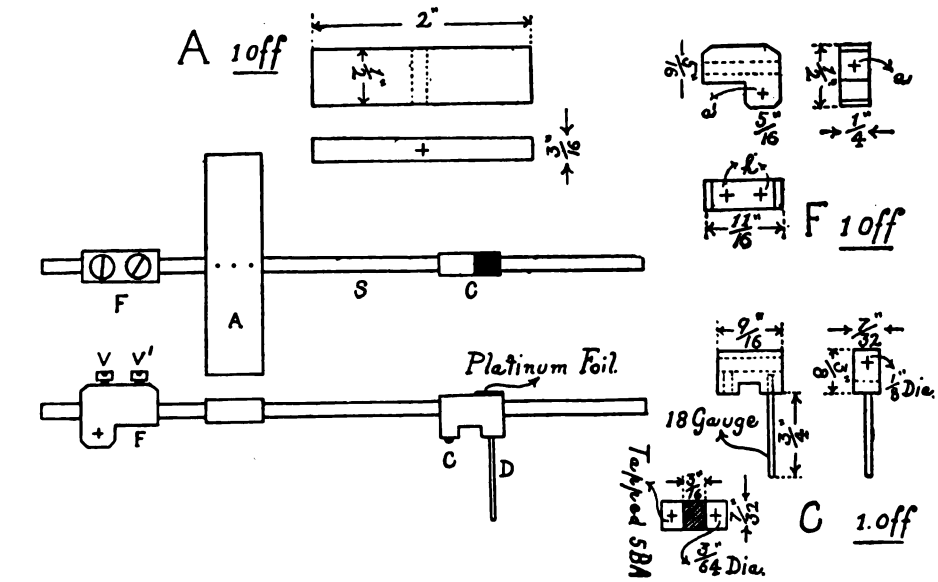

FIG. 17.

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shown, and this should be about $\frac{1}{8}$ in. deep. A $\frac{1}{8}$-in. diameter hole is drilled through lengthwise, the centre being $\frac{1}{8}$ in. from the top edge. Underneath, in the centre of the two portions either side of the recess, two holes are drilled—one drilled and tapped 5*BA* to take a short grub screw $\frac{1}{4}$ in. long, and the other drilled $\frac{3}{64}$ in. to take a $\frac{3}{4}$ in. length of 18-gauge copper wire *D*, which is soldered in position. The bottom portion of *D* should be well amalgamated, and this can be effected by thoroughly cleaning with a few drops of dilute nitric acid, to which one or two globules of mercury have been added.

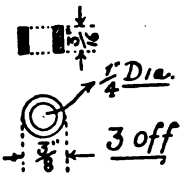

FIG. 19.

The block *F* is cut from a piece of mild steel to the size and shape given in the drawing. The hole *a* is $\frac{1}{8}$ in. diameter, and should be drilled through lengthwise, the centre being $\frac{3}{64}$ in. from the top edge. The centre of the hole a^1, which is drilled through the side of the block, is $\frac{3}{32}$ in. from the top edge, and of such a size that it will move freely upon a piece of $\frac{1}{8}$-in. diameter steel. The top edge is marked off for the holes *h*, which are drilled and tapped to take two 4*BA* cheese-headed brass screws, the screw V^1 being used to clamp the block upon the rod *S*. A small piece of platinum foil, about $\frac{3}{16}$ in. square, should also be soldered to the centre of the top edge of the contact block *C* as shown.

The bearing standard *S*, Fig. 18, can be made from either brass or steel. The slot *G* should be carefully filed out so that the block *F*, Fig. 17, will slide in easily without any side play. The holes *P* are drilled and tapped 4*BA*, while the hole *c* is drilled a tight fit for a piece of $\frac{1}{8}$ in. diameter silver steel. The stud *T* is screwed and pinned tightly into the centre of the bottom of the standard, the projecting length being $\frac{1}{8}$ in. The spring *J*, Fig. 21, is made from a piece of spring steel $1\frac{3}{8}$ in. long, $\frac{3}{8}$ in. wide, and about 28 gauge, bent to the shape given in the drawing. The hole *a* is $\frac{9}{64}$ in. diameter.

The contact screw arm *M*, Fig. 16, is of brass, and measures $2\frac{1}{8}$ in. by $\frac{1}{2}$ in. by $\frac{1}{4}$ in. The hole *S* is drilled and tapped 0*BA* to take the brass contact screw *J*, while the holes *B* are drilled $\frac{1}{4}$ in. diameter, and should be a sliding fit upon the standards *B*, Fig. 14. The screws *m*, *n* are 4*BA* cheese-headed, $\frac{1}{2}$ in. long, and are for locking the arm and contact screw in position.

Details of the mercury cup are given in Fig. 20. The arm is built up, the block *C* being screwed and soldered to the bent-brass strip *D*. The hole *P* is drilled $\frac{1}{4}$ in. diameter, and should be a sliding fit upon one of the standards *T*, Fig. 13. The hole *h* is drilled and tapped 2*BA* to take the locking screw *F*, which is a $\frac{3}{8}$ in. by 2*BA* cheese-headed brass screw. The container *S* is turned from either iron or ebonite, and the hole *n* is drilled and countersunk a tight fit for a 3*BA* steel screw $\frac{5}{8}$ in. long. The container is held in position upon the arm by means of a nut as shown.

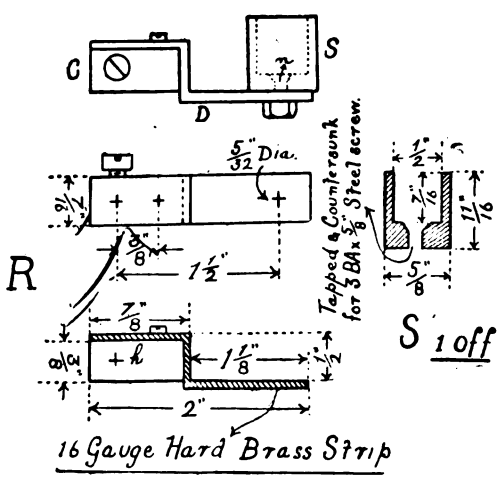

FIG. 20.

Fig. 22 gives the construction of the spring catch for holding the armature in its working position. The arm *P* is of brass and measures $1\frac{3}{4}$ in. by $\frac{1}{2}$ in. by $\frac{3}{8}$ in., and should be drilled and tapped as shown in the figure. The hole *c* should also be a sliding fit for one of the standards *T*, Fig. 13. The hole *U* should be drilled $\frac{1}{8}$ in. to take the guide rod *R*, which should be soldered in position. The 4*BA* screw

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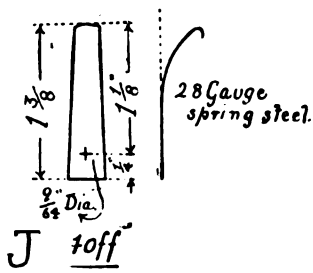


FIG. 21.

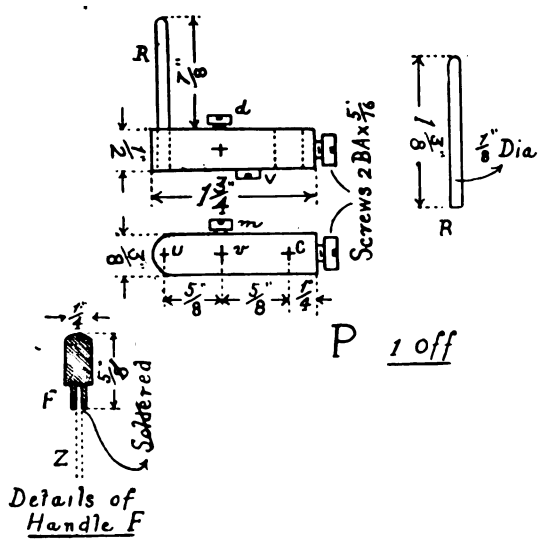
V is to hold the spring Q in position. The catch Z is cut from 18-gauge mild steel to the dimensions given, the small handle being built up and soldered on to the catch. The catch complete is shown in Fig. 23. Z is held in position upon the arm by the $4BA$ by $\frac{5}{8}$ in. steel screw m, and should be screwed up so that Z is perfectly free to move without any side play. The bent end of the spring Q should hook into the small slot cut in the bottom part of Z. The hole v in the arm is drilled and tapped $4BA$ to take the screw d which locks the screw m.

The insulating washers N, Fig. 15, are of fibre or ebonite, as are also the bushes, Fig. 19. The bobbins V, Fig. 12, are wound with 1 oz. each of No. 33 D.C.C. wire, the total resistance being 39 ohms.

The instrument can now be assembled. The cores, Fig. 12, are placed in the holes D in the baseplate and secured by means of $\frac{3}{16}$ in. plain nuts. The bushes, Fig. 19, are driven tightly into the $\frac{3}{8}$ in. holes B and filed off flush. The two standards, Fig. 14, are put through the two bushes marked B^1, an insulating washer, Fig. 15, being first placed on either side of the baseplate so as to thoroughly insulate the standards from the rest of the instrument. They are fastened in position by a nut and plain washer as shown in Fig. 14a. One of the standards, Fig. 13, fits into the remaining bushed hole B, and is insulated in a similar manner, the other standard being fastened in position in the hole F. The bobbins after being wound are slipped over the cores and connected up start to finish. The block F, Fig. 17, is fitted into the slot G of the bearing standard, Fig. 18, a short length of $\frac{1}{8}$-in. silver steel serving as a pivot. The spring, Fig. 21, is screwed to the front of the standard by the $4BA$ screw S as shown in Fig. 18, and the standard, together with the armature, is put in position in the hole F^1 in the baseplate. Before clamping finally in position it should be observed that the rod S of the armature is in perfect alignment with the centre line of the baseplate. The soft iron armature should be central in both directions over the iron cores, and should sit squarely upon them when held down.

The mercury cup, Fig. 20, is put in position upon the standard fastened at B, and the contact screw arm, Fig. 16, slipped over the two long standards and clamped in position, the correct height being 2 in. from the baseplate to the bottom of arm.

The contact screw, which should come opposite the platinum foil upon the contact block, is now screwed down until the armature is about $\frac{1}{3}$ in. away from the magnet cores, but this adjustment must, of course, be finally made by connecting up with the correct working voltage. The tension of



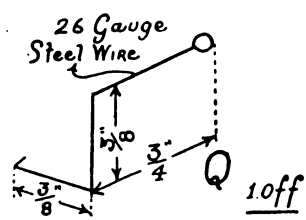


FIG. 22.

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the antagonistic spring need only be such that the contact block makes good contact with the contact screw. The mercury cup should be half filled with mercury, and the final position obtained by moving the arm upon the standard until the wire from the contact block is just clear of the surface of the mercury and in the centre of the cup when in normal position; the wire should dip at least $\frac{1}{8}$ in. into the mercury when the armature is attracted.

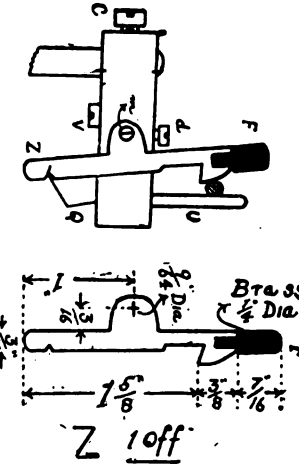

FIG. 23.

The spring catch is next placed in position upon its standard. The correct position is such that when the armature is attracted the hook of the catch can just slide forward over the armature rod, holding this down, and keeping the contact block in permanent contact with the mercury cup. The spring working the catch must have sufficient tension to work crisply, but should not be stiff enough to impede the movement of the armature. The approximate position is given in Fig. 23a. A short length of flexible wire with a small thimble each end, or a close spiral of 22-gauge copper wire, should be clamped under the screw V, Fig. 17, and the screw S^1 on the bearing standard.

The mahogany stand, details of which can be gathered from the photograph of the finished instrument, measures 8 in. by 6 in. by $\frac{3}{8}$ in., and is mounted upon four turned feet about 1 in. long. The board is cut away to clear the various nuts underneath the baseplate, and the instrument fastened down by round-headed wood screws through the holes C, Fig. 11. The disposition of the instrument and terminals, together with the connections, is given in Fig. 24. As shown, the two remaining ends of the coil windings are coiled up and connected to two studs, which are in turn connected to the two left-hand terminals marked C.

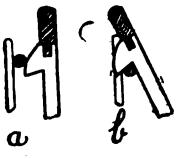

FIG. 23A.

The three terminals marked T, H, N are connected as follows: A connection is taken from one of the insulated standards carrying the contact screw to the terminal H, another from the insulated standard carrying the mercury cup to the terminal N, and one from the bearing standard to the terminal T. The shanks of the standards, etc., are long enough to take a second nut for making these connections, which are of 18-gauge copper wire. The terminals should be marked in some way with the letters given in the diagram, preferably by means of small engraved plates which can be screwed to the stand. The terminals C are connected to terminals No. 12 on the switchboard, and the terminals T, H, N to terminals No. 7, which are correspondingly marked. When working, the magnet coils take $\frac{1}{3}$ ampere at 12 volts, which current can be passed by the polarised relay without damage to the contacts.

No mention has been made with regard to the finish of the instrument, as the finish of this, as well as the remaining pieces of apparatus, will depend upon the ability and inclination of the builder.

(An error occurs in Fig. 24. The letters T, N should be transposed.)

(To be continued.)

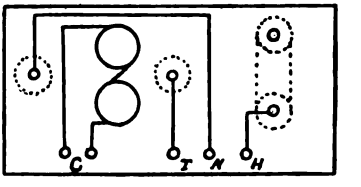

FIG. 24.

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Wireless and Meteorology

A Lecture at the Royal Society of Arts

On Wednesday, January 22nd, Sir William Napier Shaw, Director of the Meteorological Office, occupied the chair at a meeting of the Royal Society devoted to the reading of a paper by Colonel H. G. Lyons, D.Sc., who took for his subject "Meteorology, during and after the War."

Colonel Lyons had been Director-General of the Survey Department in Egypt, and—after his return to England—had been lent by the Minister of War to the Meteorological Office, subsequently taking over the whole work carried on there. He dealt with his subject from a variety of aspects.

During the war, said he, special facilities were given for the rapid transmission of reports. Kite balloons had been able to furnish a series of observations at various heights. Pilot balloons at perhaps 100 stations were engaged in observations four (or more) times daily. Aeroplanes had been available for observing the temperature in successive layers of the atmosphere up to 12,000 feet or 14,000 feet; whilst the velocity and direction of air currents up to 25,000 feet and more had been determined by the bursting of shells fired at high angles. In these and other ways a vast store of information has been amassed, available for future study.

The lecturer then passed on to emphasize the rapidity of weather changes: "even wireless reports from ships give but a short period of warning in many cases." He adverted, in passing, to the difficulties introduced on the outbreak of war, when simultaneously with all sorts of new disabilities there arose an increased and insistent demand for practical meteorological information, and dwelt effectively upon the contrast between the enemy and ourselves in this respect, pointing his critical remarks with the pregnant observation that this war "is the first in which meteorology has been regularly used" for combatant purposes.

The importance of the subject to the aeroplane service, to kite balloons, and indeed to all forms of aviation, constituted the next item in his discourse. Whilst these new branches of activity made fresh demands upon meteorology, they at the same time introduced fresh aids in its systematization and extension. He referred to the necessity for co-ordination between the four State Meteorological Services now in operation, and then turned to the subject of "Short Period Meteorology" and the Issue of Forecasts. He emphasized the assistance which could be expected from the extension of wireless telegraphy and telephony, expressing a hope that every country will, ere long, be radiating meteorological observations from selected stations four times daily at fixed hours, in much the same way as is followed by the Eiffel Tower station, which sends into the ether Time and Weather Signals thrice per diem. A reference to the peculiarly favourable position of Great Britain, with its far-flung Empire, for the organisation of this important branch of knowledge, closed a highly instructive and interesting paper.

The discussion which followed was opened by the Chairman, who narrated an amusing incident which showed how the assumption, by a practical airman, of the availability of certain information, led directly to its initiation. The Astronomer Royal, Sir F. Watson Dyson, and Colonel L. P. Blandy laid special emphasis upon the necessity for co-relating the work of four different meteorological organisations now in existence. Mr. T. H. Blakesley referred to the daily publication of weather charts by the *Times* and *Morning Post* as evidence of the wider public interest taken in the subject. He deprecated the introduction of unnecessary technical terms such as "millibars." Mr. F. G. Ogilvie and Mr. Carle Salter dealt with the important future before the science, whilst Mr. R. G. K. Lempfert criticised the attitude taken up by the Universities. A brief summation of the discussion by the Chairman and a vote of thanks terminated the proceedings.

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Instructional Article

NEW SERIES (No. 12)

EDITORIAL NOTE.—Below we give the last of a series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

VALENCY, CHEMICAL AND ELECTRO-CHEMICAL EQUIVALENTS.

VALENCY.

GENERALLY speaking it may be said that an atom of any element has a definite degree of "affinity" for any other kind of elementary substance. This "affinity" or tendency to combine is explained nowadays by theories dealing with the electrical state of atoms, for details of which the reader must have recourse to an account of the electron theory. In thinking about the "affinity" of an atom we must distinguish between the degree of what may be called its *eagerness* to combine with another kind of matter and the extent to which it actually does so combine. When an atom is in combination with others its *eagerness* to combine with them is precisely the same as it would be were the atom not combined with them, because this eagerness is an inherent quality of all atoms of that particular kind. As a parallel to this we may consider the tendency of a compass needle to set itself in a certain manner relative to a magnetic field; when it has assumed its characteristic position in the field its *tendency* to do so remains the same as ever. But the *extent* to which an atom will combine with others varies, not only according to the particular kind of atoms with which it is brought into contact, but with conditions such as temperature and pressure. Under different conditions an atom will exhibit different combining powers, even with the same class of atoms; yet although this power is variable its degrees are known and can be stated for any given case where the formula is known. Luckily it is not infinitely variable, as will be seen later. Research has shown that there seems to be a well-defined limit to the number of hydrogen atoms with which an atom of another substance will combine, assuming that there are not present any atoms of a third kind. In the case of any *element capable of combining with hydrogen* this number represents its valency, or, to be more precise, it represents its valency as measured by hydrogen; the atom may have more than one valency. Measured in this way the valency of chlorine is 1, because its atom never combines with more than 1 atom of hydrogen. Chlorine, therefore, is called a **monad**; it is monovalent.

Measured by hydrogen.

- Oxygen is **di**-valent. *E.g.*, H_2O (Water).
- Phosphorus is **tri**-valent.* *E.g.*, PH_3 (Phosphoretted hydrogen).
- Nitrogen is **tri**-valent.† *E.g.*, NH_3 (Ammonia).
- Silicon is **tetra**-valent. *E.g.*, SiH_4 (Silicon hydride).

The valency of those elements which will not combine with hydrogen is measured by their capacity to combine with some monovalent element. Thus,

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* Phosphorus is also penta-valent.

† Also penta-valent.

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although tin will not combine with hydrogen, if we take the monad chlorine for our standard the valency of this metal is 4. *E.g.*, Stannic chloride, $SnCl_4$.

Measured by chlorine.

- Sodium is **mono**-valent. *E.g.*, NaCl.
- Calcium is **di**-valent. *E.g.*, $CaCl_2$.
- Boron is **tri**-valent. *E.g.*, BCl_3.
- Titanium is **tetra**-valent. *E.g.*, $TiCl_4$.
- Phosphorus is **penta**-valent. *E.g.*, PCl_5.
- Tungsten is **hexa**-valent. *E.g.*, WCl_6.

Most elements possess more than one valency. For example, measured by its combination with hydrogen, phosphorus has a valency of 3; whereas measured by chlorine its valency is 5. In cases such as this the valency of an element is generally given as the *highest number* of monovalent atoms with which its atom will combine.

If an element will not combine with hydrogen it may be capable of *replacing* it during a chemical action, and then its valency is measured by the number of hydrogen atoms replaced. If sodium is brought into contact with water one sodium atom replaces one hydrogen atom in the water, sodium hydrate (NaHO) being formed; hence sodium is monovalent.

There are cases of compounds in which are found atoms with their affinities satisfied partly by one kind of matter and partly by another kind. For example, nitrogen is tri-valent in its combination with hydrogen or chlorine, yet in ammonium chloride (NH_4Cl), a compound which it forms with both of these elements together, it is *penta*-valent, for its atom is combined with 5 monovalent atoms.

When in a molecule all the atoms are combined to the fullest extent of their valency the compound is said to be saturated. It must be remembered that a trivalent atom can be satisfied equally well by (*a*) three monovalent atoms (*b*) one monovalent atom and a divalent atom, or (*c*) a trivalent atom; the rule applies similarly no matter what valency is considered.

Saturated compounds.

- Chloride of Boron, BCl_3.
- Water, H_2O.

In these cases all the affinities of each element are satisfied.

Unsaturated compounds.

- Phosphoretted hydrogen, PH_3.
- Ammonia, NH_3.

In these cases only three of the five affinities of the phosphorus and nitrogen atoms are satisfied. Unsaturated compounds, by virtue of the surplus combining power of their atoms tend, as might be expected, to combine readily with other substances.

There are a number of exceptional cases involving problems which are still outstanding, for valency is in most instances a variable quantity dependent upon prevailing conditions. Helium, Neon, Argon, Krypton, and Xenon have no valency, at least so far as our present knowledge goes, because no compounds of any of these gases have yet been discovered.

The "monovalent atom" which serves as a measure of valency is a working unit, but is not considered to be sufficiently fine, inasmuch as it leads us to state valencies as simple multiples of 1, whereas it is not unlikely that the combining capacity of any element might be more accurately expressed by a mixed number.

CHEMICAL EQUIVALENTS.

In the foregoing brief explanation we have regarded valency as an inherent property of the atom *exhibiting* itself to a degree dependent upon various conditions, and we have seen its value in a few cases by a reference to formulæ.

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There is, however, another means of arriving at the valency of the elements, to understand which the reader must examine the following lists:

(*a*) In H_2O **8 parts** by weight of **O** combine with **1 part** by weight of **H.**
In HCl **35·5 parts** ,, ,, **Cl** ,, ,, **1 part** ,, ,, **H.**
In H_2S **16 parts** ,, ,, **S** ,, ,, **1 part** ,, ,, **H.**

(*b*) In Cl_2O **8 parts** by weight of **O** combine with **35·5 parts** by weight of **Cl.**
In SCl_2, **16 parts** ,, ,, **S** ,, ,, **35·5 parts** ,, ,, **Cl.**
In $SbCl_3$, **40 parts** ,, ,, **Sb** ,, ,, **35·5 parts** ,, ,, **Cl.**

In each of these lists, it will be noticed, there are shown the number of parts by weight of various elements which combine with a certain number of parts by weight of another element. Taking list (*a*) we see that oxygen, chlorine, and sulphur combine separately with hydrogen in the proportions of 8 : 1, 35·5 : 1, and 16 : 1 respectively. In this sense, therefore, 8 parts by weight of oxygen, 35·5 parts by weight of chlorine, and 16 parts by weight of sulphur are said to be chemically *equivalent*, and the quantities 8, 35·5, and 16 are respectively the **chemical equivalents** of those elements.

Now a peculiar relation exists between the chemical equivalent of an element and its atomic weight, which may be seen by looking at the figures on the left hand side of the above tables (*a*) and (*b*). Beginning at oxygen and working downwards, notice the following:

Oxygen .. Atomic weight **16.** Chemical equivalent **8.** Ratio is $\frac{16}{8} = 2.$

Chlorine .. ,, ,, **35·5** ,, ,, **35·5** ,, $\frac{35.5}{35.5} = 1.$

Sulphur .. ,, ,, **32** ,, ,, **16** ,, $\frac{32}{16} = 2.$

Antimony .. ,, ,, **120** ,, ,, **40** ,, $\frac{120}{40} = 3.$

In the case of oxygen it is seen that the value of the ratio of its atomic weight to its chemical equivalent is 2; this is the *number of hydrogen atoms with which an atom of oxygen will combine* (as in H_2O, the example given), and this is what has been called the *valency* of oxygen. Following the same idea out in the other cases we find that chlorine is monovalent, sulphur divalent and antimony trivalent. Note that in list (*b*) the standard is chlorine instead of hydrogen.

It follows, then, that valency may be regarded either as a property of the atom or the ratio of its atomic weight to its chemical equivalent.

ELECTRO-CHEMICAL EQUIVALENTS.

Conductors of electricity may be divided into two kinds—viz., those which simply become heated when current flows through them, and those which under the same conditions are *electrolysed*, or *decomposed*. For instance, a copper wire becomes hotter when it conducts electricity, but if current is passed through a solution of copper sulphate the latter is decomposed; metallic copper is deposited on the kathode or negative *terminal* of the battery, whilst the (SO_4) group passes to the anode or positive *terminal* of the battery and combines with water to form sulphuric acid and oxygen.

If a current is passed through water which has been slightly acidulated with sulphuric acid it is ultimately decomposed into hydrogen and oxygen. Hydrochloric acid yields on electrolysis hydrogen and chlorine. Fig. 38 represents an arrangement suitable for the electrolysis of a liquid, e being the kathode and e_1 the anode; these two electrodes are platinum strips. Let us suppose that we *shut* the stopcocks and fill up the reservoir and tube R with slightly acidulated

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water.* On opening the stopcocks the liquid rises in the side tubes, filling them and expelling the air; the stopcocks are then closed again. We will now suppose that a current of 1 ampere is passed through the electrolyte for 1 hour. Hydrogen will be evolved at e and rise to the surface in bubbles; oxygen will be released at the anode e_1, and will escape in the same way. At the end of 1 hour we break the circuit and observe the level of the liquid in each side tube. That in the hydrogen tube may have sunk, say, to L_1 in Fig. 38 (*a*), in which case the level in the oxygen tube will have sunk only to L_2, that is, only half as far. This demonstrates that the volume of hydrogen evolved by the *same current* is twice that of the oxygen.

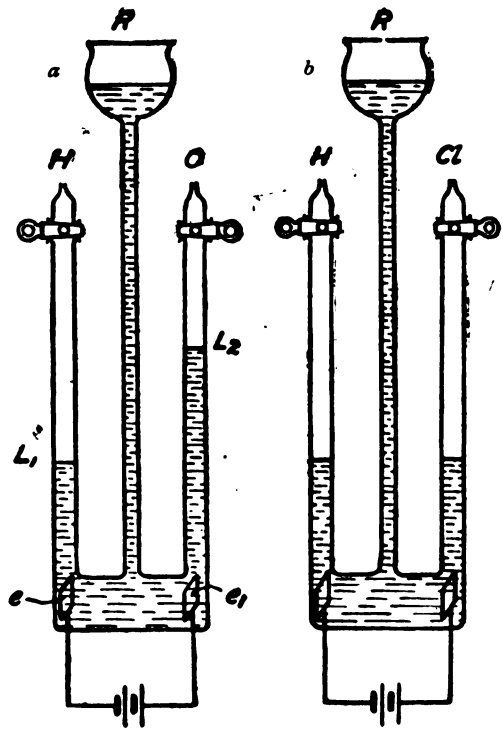

FIG. 38.

Repeating the experiment with hydrochloric acid in the tube we find (Fig. 38 (*b*)) that hydrogen is evolved at e and chlorine at e_1, and that the *volumes are equal*, not only to each other, but also to the volume of hydrogen obtained in the first experiment. If the side tubes are graduated and both experiments are conducted under precisely similar conditions by the simultaneous use of two electrolysis tubes in series with each other and the battery, these results can be very accurately shown.

Now, from what we have learned about atomic weights we know the relative weights of *equal volumes* of hydrogen, chlorine, and oxygen to be respectively 1, 35·5 and 16. Therefore, bearing in mind the *relative volumes* (1, 1 and ½) of these gases released in the experiments, it is easy to see that they must have been released in the proportions **by weight.**

H .. .. 1 Cl .. .. 35·5 O 8

Similarly, if we electrolyse solutions of various salts we get definite amounts of metal deposited on the kathode as a result of the passage of a given quantity of electricity. Taking as a standard that quantity of electricity which will liberate **1 gramme of hydrogen**—viz., **96,540 coulombs**—it is found that this will release or deposit electrolytically:

1	gramme of	Hydrogen.
35·5	grammes of	Chlorine.
8	,,	Oxygen.
108	,,	Silver.
31·7	,,	Copper (cupric).
63·5	,,	,, (cuprous).
40	,,	Antimony.

If the reader will refer back he will see that these numbers are the same as the *chemical equivalents* of the elements mentioned; but it is obvious from the

* The acid is added to assist the decomposition of the water, which by itself is not a good conductor of electricity.

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list just given that these quantities of the elements are also equivalents in an *electro*-chemical sense. The electro-chemical equivalent of an element is the ratio of its atomic weight to its valency, and is the same as its chemical equivalent.

It will probably occur to the student of electricity that whilst he has seen the electro-chemical equivalent of copper quoted as 0·00328 (C.G.S.) or 0·000328 (ampere equivalent) he has not noticed it referred to as 31·7. This is simply a matter of the size of the units chosen to express the electro-chemical equivalent. The proportion by weight of *copper deposited* to *hydrogen liberated* by any given quantity of electricity is invariable, and is 63 : 1 or 31·7 : 1 according to the particular copper salt electrolysed, and the amount of metal deposited by electrolysis is strictly proportional to the quantity of electricity passed. We took as a standard that quantity of electricity which will release 1 gramme of hydrogen because by so doing we arrive at figures which show at a glance that the chemical equivalent of an element is the same as its electro-chemical equivalent, and is the quotient of its atomic weight by its valency. Now the electro-chemical equivalents of the six elements shown in the foregoing list were given in **grammes per 96,540 coulombs**; but the (practical) electro-magnetic unit of quantity is **1 coulomb**, an amount which will liberate $\frac{1}{96540}$ gramme of hydrogen. Therefore if we consider the electro-chemical equivalent as **grammes liberated per coulomb** we shall come into line with everyday electrical practice, for the **C.G.S. electro-magnetic unit of current is that steady current which will deposit from a solution of copper sulphate 0·003281 gramme of copper * in 1 second.** One tenth of this current is called an ampere, and, flowing for 1 second, the ampere will deposit 0·0003281 gramme of copper. But the quantity of electricity conveyed by 1 ampere in 1 second is 1 coulomb; hence 1 coulomb will deposit ·0003281 gramme of copper from a solution of copper sulphate, and this value (·0003281) is the ampere electro-chemical equivalent of copper.

Let us see whether this is in agreement with the previous statement to the effect that the electro-chemical equivalent of copper is 31·7.

If 96,540 coulombs deposit 31·7 grammes of copper from a solution of copper sulphate, then 1 coulomb will deposit

$$\frac{31{\cdot}7}{96540} = \mathbf{{\cdot}000328} \text{ gramme.}$$

Thus it is seen that the value of the ratio of the amount of copper deposited to the amount of electricity which deposits it is the same whether we state the electro-chemical equivalent in terms of grammes per 96,540 coulombs, as is often done by chemists, or in terms of grammes per coulomb, as is the custom of electricians.

$$\textbf{Copper}: \frac{31{\cdot}7 \text{ (grammes)}}{96{,}540 \text{ (coulombs)}} = \frac{{\cdot}000328 \text{ (gramme)}}{1 \text{ (coulomb)}} = {\cdot}000328.$$

$$\text{Electro-chemical equivalent by method explained above} = \frac{63{\cdot}5 \text{ (Atomic weight)}}{2 \text{ (Valency in } CuSO_4)} = 31{\cdot}7$$

Share Market Report

A FAIRLY active business has been done in the shares of the various Marconi issues during the past month. Prices are well maintained, the shares of the Marconi International Marine showing a marked improvement. Prices as we go to press are :—Marconi Ordinary, £4 11s. 3d.; Marconi Preference, £3 18s. 9d.; American Marconi, £1 9s.; Canadian Marconi, 12s.; Spanish and General, 13s.; Marconi International Marine, £3 16s. 3d.

* The Standards Committee of the B. of T. take silver nitrate as the electrolyte. One coulomb deposits 0·001118 gramme of silver.

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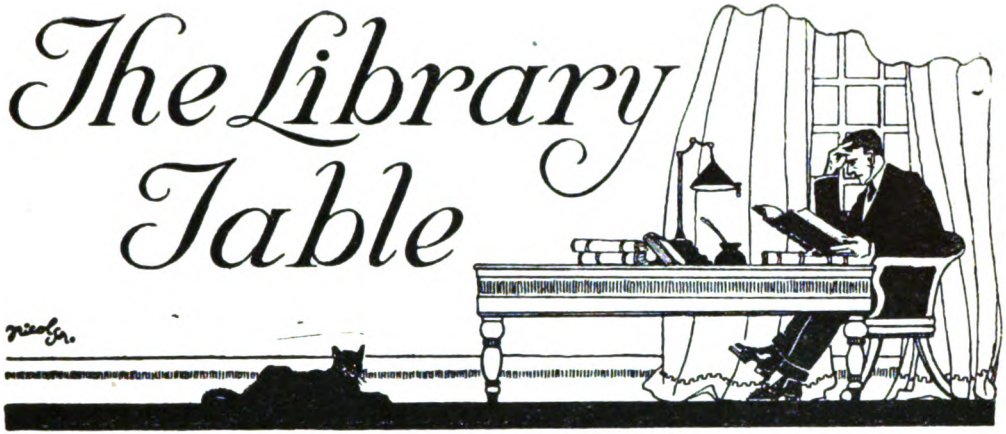
The Library Table



PSYCHIC SCIENCE: An Introduction and Contribution to the Experimental Study of Psychical Phenomena. By Emile Boirac. London: Wm. Rider & Son, Ltd., 8, Paternoster Row, E.C.4. Price 10s. 6d. net.

Medieval philosophers almost universally maintained that behind everything, material and immaterial alike, there lay some force or first principle to which it all owed its causation. Robert Browning has set forth their philosophy in his *Paracelsus*, the hero of which—imbued with this belief—convinced himself that if he could only attain to this basic principle, he would grasp all knowledge simultaneously; and benefit mankind by obviating the necessity of creeping by slow and painful stages to the revelation of Nature's secrets of existence and creation.

This old idea receives some confirmation from the fact that every great discovery of principle leads directly to a number of others. Thus the formulation of the "germ theory" led to a number of useful discoveries in the somewhat empiric science of medicine.

In a similar way, the exposition of the undulatory theory of light by Thomas Young in 1801 was followed by the discovery of the "Hertzian Waves" later on in the century, and finally crowned by the epoch-making inventions of Marconi. This series of discoveries fired the imagination of scientists, and induced a number of investigators in fields other than electric to proceed along similar lines.

In the book under review there are plain evidences of the influence exerted by radiotelegraphy upon the distinguished French author. For instance:—In speaking of telepathy—*i.e.*, that branch of psychic science which deals with mental suggestion and thought-transmission—he discusses the possibility that "Certain deceased "persons concentrated all their powers of expiring thought on beings who are dear "to them, and this concentration has, in spite of distance, produced a telepathic "impression on the brains of their relatives or friends." Such an explanation of well authenticated phenomena he parallels by illustrations drawn from wireless telegraphy, likening the thought of the dying person to "a kind of spontaneous "discharge, similar to that of the electric condenser, immediately followed by "oscillations or undulations capable of rapidly traversing great distances and "finally disturbing a material object." Again, when dealing with human radiation, an hypothesis which led to our author's conducting some of his most interesting experiments, we find him deprecating astonishment "that a force can thus exist "and act in a permanent manner without generally making its existence and action "known by any appreciable result," by referring to the fact that "the most recent "discoveries of science have already begun to familiarise savants with the notion "of such a force. Without speaking of electricity, which was so long ignored, but "which, nevertheless, plays so considerable a part in Nature, we will refer to the

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" waves known as Hertzian, which accompany electrical discharges and which " traverse all bodies with an inconceivable rapidity. . . . Similarly, the alternative " high frequency currents, studied by Professor d'Arsonval, cross different bodies, " and especially the human body, in such conditions that it is impossible to perceive " their passage ; and yet it is sufficient to modify these conditions, and the individual " whom they traverse may immediately be stunned. We can, moreover, reveal " them by placing in the hands of an individual an electric bulb, which will become " luminous under their influence. It is, therefore, by no means opposed to scientific " analogies to suppose that the human body itself emits radiations of this character."

It would be interesting to pursue the matter further, and to trace the influence exerted by wireless discoveries upon the views of psychic theory adopted by the author, and the lines of investigation which are directly attributable to radio-telegraphic influence. Space, however, does not permit and we must refer readers to the volume itself ; they will find that it amply repays careful study generally, as well as from this specialized point of view.

We would particularly commend to scientific experimenters, who desire to draw correct deductions from the results of their labour, and to avoid the multiplication of useless experiments, M. Emile Boirac's illuminating chapter dealing with the " Paradoxes of Causality." Some of it will, of course, be found familiar by trained observers ; it is, for example, a commonplace that the experimental method consist of four operations : (1) observation, (2) hypothesis, (3) experiment, and (4) induction. But it is by no means so widely remembered (at all events, in practice) that the *order* is of paramount importance. M. Boirac illustrates this fact by instances set forth in a very lucid and informative manner. The error made by the medieval philosophers to whom we refer in our opening sentence was that they mostly reversed the correct rotation of the " Method " enunciated above.

ITALY'S GREAT WAR AND HER NATIONAL ASPIRATIONS. By Mario Alberti, General Carlo Corsi, Armando Hidnig, Tomaso Sillani, Attilio Tamaro and Ettore Tolomei. With an Introductory Chapter by H. Nelson Gay. Editors, Alfieri and Lacroix. Milan.

It is by no means due to any desire for employing an elegant periphrasis that we have on several occasions referred to Italy as " the Fatherland of Marconi." The renowned inventor of wireless telegraphy is only one of a long line of illustrious scientists from this ancient centre of civilisation. It is as the living embodiment of an honourable tradition that he represents his Motherland. In many other lands distinguished scientists and men of letters hold themselves aloof from the general life of their country ; this never has been, and is not to-day, the case with Italy. Consequently, when the writers of this compendiumistic volume desire to emphasise the war indebtedness to Italy of France and the world at general they can find no more apposite way of so doing than that of quoting from a speech delivered by Guglielmo Marconi during his visit to the U.S.A.

We recommend any Englishman who is interested in the problems which the Peace Conference at Paris has to solve (and who worthy of the name of Englishman can fail to be deeply concerned therewith ?) to get hold of this volume and read it through. It only runs to 267 pages, and compresses the essential features of the whole story within its bulk.

Large numbers of us even yet fail to appreciate the martyrdom of those Italians who were held under Austrian domination in the districts known to the subjects of King Victor Emanuel as " Italia Irredenta " (*unredeemed Italy*). So long was this continued and so thoroughly was the work done, that those ex-subjects of Austria, who were utilised for that Jesuitical Power's fell purpose, are now claiming for themselves, under the title of Yugo-Slavs, large tracts of the country Italy has shed so much blood to save.

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Personal Notes

Meritorious Service Medal for Wireless Work.

We have been advised that Sergt. R. J. Parker has received the M.S.M. for wireless work in Italy during the campaign of 1918. He has been engaged in working direction finding apparatus with excellent results.

Mentioned in Despatches.

Readers of the valuable articles which have appeared from time to time in this magazine from the pen of J. Scott Taggart, R.E., will be interested to learn that this popular author has recently been mentioned in despatches for wireless work during the fighting of 1918. We are also advised that Lance-Corporal R. Heffer and Sapper D. Gorsuch, two wireless operators attached to Mr Scott Taggart's section, have been awarded the Military Medal for gallantry in maintaining wireless communication during battle. We take this opportunity of offering our congratulations to these brave men.

The *Journal Telegraphique* announces the nominations of M. Joseph Hollos to be Director-General of Posts and Telegraphs for Hungary, and M. E. P. Westerveld to be Director-General of Posts and Telegraphs for the Netherlands.

Military Medal for R.A.F. Wireless Operator.

For devotion to duty with the wireless section of the R.F.C. at Agincourt, of historic fame, Air Mechanic H. Potter has been awarded the Military Medal. Notwithstanding heavy fire, Boche shells frequently falling close to the dugout, Mr. Potter maintained wireless communication under the most difficult circumstances.

Wireless Board.

We understand that the new Wireless Board which has been established under Capt. R. A. Slee, R.N., for the purpose of conducting research work is to consist of three naval members, two military members, and two Air Force members.

Eiffel Tower Signals in an Elementary School.

A pioneer of wireless telegraphy in the schools, Mr. Frank Henry Wright, has died at Bugbrooke, Northamptonshire, aged 66. He was for 32 years a schoolmaster at Bugbrooke, and in the early days of wireless, with the scholars' aid, he extemporised an installation out of crude material. This was erected at the school, and time signals from the Eiffel Tower were regularly taken by the scholars, who shared his enthusiasm in the science. Several scholars have since become wireless operators.

The death is announced of Monsieur Joseph De Volder, Minister of State and Senator of Belgian Luxembourg. During his lifetime he held the positions of Minister of Justice and Vice-Governor of the Société Générale de Belgique. He was elected President at the inception of the Banque d'Ontremer, The Marconi International Marine Communication Co., Ltd., and the Compagnie de Télégraphie sans Fil, and was connected with these companies for many years.

Mr. M. J. Hartigan, who joined the Shore Wireless Service in January, 1916, died from influenza on November 26th, 1918. The deceased was an operator in the service of the Marconi International Marine Communication Co., Ltd., previous to the outbreak of war, and his death is deeply regretted by former colleagues.

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Questions & Answers

ANNOUNCEMENT

We have again received a number of queries from our readers regarding the prospects and conditions in the Mercantile Marine wireless service. Enquiries of this nature should be addressed to :—The Traffic Manager, The Marconi International Marine Communication Company Limited, Marconi House, Strand, London, W.C.2.

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless telegraphy. Readers should comply with the following rules :* (1) *Questions should be numbered and written on one side of the paper only, and should not exceed four in number.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (4) *The Editor cannot undertake to reply to queries by post.* (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (6) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

F. H. (Worksop) asks :—What is the difference between a multiphase generator and a monophase generator, also a multi-pole generator ?

Answer.—We are not sure whether the question refers to the difference in design of these machines or to the nature of their output. Alternators may be wound in such a manner as to generate a number of separate E.M.F.'s of similar frequencies reaching their maximum values at different instants of time. The output of each winding is a phase, and the armature of a multiphase generator is wound with as many separate windings as there are phases in its output. A monophase machine is one which generates alternating E.M.F. of one phase only. Multipolar is the name usually given to a generator having more than two poles. A two-pole machine is usually termed bi-polar.

F. H. (Dublin).—Apart from wireless qualifications there is the question of medical fitness. We should suggest that you make application at the local recruiting office.

MISS B. L. (Perth).—You might perhaps arrange a course of instruction in wireless telegraphy at one of the schools advertised in this magazine. We are not aware of any openings for ladies as wireless operators at the present time.

F. W. N. (Plymouth).—Refer to page 94 of the May, 1918, issue of THE WIRELESS WORLD.

C. P. L. (Egypt).—We do not know of any training school offering free scholarships.

A. L. (Catford).—(1) Suitable applicants in possession of first-class certificates applying to the Traffic Manager are placed on the waiting list to be called upon as the necessity arises. (2) The possibilities of promotion are plainly set forth in the Conditions of Service. See notice at the head of these columns.

A. S. D. (Kensington). asks the following question :—If a steel magnet were to be placed on a pivot inside a circular magnet without a break in it where would the needle point ?

Answer.—In the first place you do not say whether the steel needle has been magnetised. If the conditions are as above stated the whole of the magnetic flux would be confined to the circular magnetic path surrounding the needle, and presuming there to be no leakage at any point, the needle not being magnetised might take up any position. If the needle were magnetised it would, of course, act as a compass needle and point north and south. In either case the presence of the surrounding magnetic circuit would have no influence on the direction in which the needle would point.

P. C. (Ashton-under-Lyne).—Appendix 5 of the Postmaster-General's handbook for wireless telegraphists indicates the requirements of the Postmaster-General's Examination. A number of schools advertising in this magazine train men for this certificate, without which you cannot sign on as a wireless operator on a British merchant ship. We suggest that you might write for prospectuses.

W. H. (Caton).—(1) For cost of tuition you might write for a prospectus to one of the schools advertising in this magazine. (2) The cost of an outfit would depend upon your personal tastes and present stock of clothing. Previous to the issue of the Mercantile Marine Order, uniform could be procured for about

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£10. (3) See notice at the head of these columns. (4) For information regarding the requirements of the Postmaster-General's Examination refer to Appendix 5 of the Postmaster-General's handbook for wireless telegraphists.

H. R. L. (West Croydon).—(1) No man is accepted as a student in the Marconi Company's school; it is, at the present time, necessary to possess the Postmaster-General's First Class Certificate. (2) The time required to master the practical side of wireless telegraphy is to some extent dependent upon natural ability. An average student can attain a speed of 20 words per minute in from four to six months. (3) See notice at the head of these columns.

M. P. P. (Bristol).—In order to become a wireless operator on board ship it is necessary to possess the Postmaster-General's Certificate. The requirements of the examination are given in Appendix 5 of the Postmaster-General's handbook of instruction for wireless telegraphists. (2) See answer to P. C. (Ashton-under-Lyme). (3) There are wireless schools at Birmingham and Cardiff, which advertise in this magazine.

F. M. W. (Hitchin).—(1) and (2) At the present moment the question of patents in use by the Government is not decided. In time of war the Government allocate to themselves the right to use any patent which is of sufficient importance. We are therefore not in a position to make a statement as to patentees of the apparatus you mention and for a similar reason are unable to forecast its future. (3) We have received no information whatever as to when the present restrictions regarding private wireless telegraph installations will be withdrawn.

AMBITION (Saltney).—(1) We should be pleased to consider any suggestion you may have for an easy method of learning the Morse code. (2) In case of acceptance the purchase price would be in accordance with the value of the invention. (3) Your question is not at all clear. Does your enquiry relate to a wireless telephone transmitter worked from an induction coil? No system of damped waves is suitable for this purpose. Wireless telephony is carried on almost entirely with continuous waves which cannot be produced by means of apparatus using an interrupter for obtaining high tension.

E. V. D. (Madeira).—There is a magnetometer on the market working on the principle of the increase in resistance of bismuth when acted upon by a magnetic field. This instrument is often used for measuring the field strength of generators, as it can easily be inserted between the pole pieces and the armature. The following data may be of use to you: "With values of the inductance "density varying from zero to 40,000 C.G.S. "units, the resistance of pure bismuth wire "will increase nearly threefold. A fine "bismuth wire is wound inductively in a "spiral coil and encased in a mica capsule, the "entire thickness being less than one milli-"metre. The normal resistance, R_0, having been "measured, it is placed successively in fields "of increasing strength, the resistance being "measured for each value of H. A curve "showing the relation between the values of "H and R enables us to interpolate any value "of H for any given value of R."—*Electric and Magnetic Measurements*, by Charles M. Smith.

F. J. L. (London) suggests that if an operator is transmitting on continuous waves with very loose coupling the strongest signals will be got by the receiving operator when the coupling in the receiving station is the same value as that of the transmitter. He takes an hypothetical case wherein he assumes that the signals will become inaudible if the coupling at the receiving station is tightened too much

Answer.—This is not the case. The coupling at the receiving station amongst other things, is dependent upon the damping of the receiving circuits. If heterodyne reception is being employed this will also effect the coupling of the receiver. (2) If the correct coupling is known to be five per cent. at the receiver and the high-frequency transformer in use was wound in the same manner as a low frequency transformer—*i.e.*, for maximum tightness of coupling—the amplitude of the oscillations in the secondary would be largely reduced. Such an arrangement might to some extent be compared to the results obtained when the detecting apparatus is connected directly across the aerial tuning inductance. (3) No system using damped waves is as satisfactory for the purpose of radiotelephony as systems using continuous waves. The Lepel system, which has a fundamental spark frequency above audibility, can be used for this purpose. Experiments have been carried out in this direction with a fair measure of success, but have never reached the same high degree of efficiency as other systems using continuous waves. (4) The Institute of Radio Engineers is an American institution. Their headquarters are at the College of the City of New York. We should suggest that you communicate with the secretary on the subject. Under the heading of "Correspondence" in this issue is a letter dealing with the formation of radio clubs, which may interest you.

C. R. (Hammersmith).—In a rotary spark gap, why should the fixed and moving spark electrodes be adjusted to give a minimum working distance? For example, on small power sets using discs of small diameter and comparatively short waves the peripheral speed of the disc is too low to "quench" the spark. It would appear that if the fixed and moving studs were separated and drawn apart to give a minimum clearance slightly less than the breakdown sparking distance (due to condenser P.D.), then any

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low number of oscillations might be obtained in the primary circuit. The decrement due to the greater spark resistance would not be a drawback in this case.

Answer.—Whether the distance between the fixed electrodes and the moving studs be adjusted to the minimum working length or to a maximum length would not alter the fact that the whole of each train of oscillations would be completed whilst the moving electrode was underneath the fixed electrode, unless the peripheral speed of the disc was sufficiently high to produce a quenching action. Your suggestion to increase the length between the fixed and moving electrodes would not produce quenching, but would merely lessen the length of each train of oscillations by the amount of energy lost in heat in overcoming the increased spark gap resistance. It seems to us that you are not clear on the subject of quenching itself. Quenching may be defined as the early stoppage of the primary current brought about by the extinction of the spark. The disappearance of the spark opens the primary circuit and leaves the secondary free to oscillate with its own frequency.

Question 2.—In a multiple plate quenched gap, Mr. Bangay attributes the "quenching" to the rapid conduction and dispersion of heat by the plates. Yet E. E. Bucher, in *Practical Wireless Telegraphy*, insists that the gaps must be airtight, which would hamper cooling. Is not the quenching partly due to the fact that the heat of the spark expands the air in the gaps, thus increasing the pressure and dielectric strength until this becomes prohibitive?

Answer.—Although the quenching action of a multiple plate gap may be attributed to a number of causes yet they can all be traced to the rate at which the heat generated in the gap is dissipated. For instance, it is held by some writers that the extinction of the spark is due to deionisation of the gases between the plates. The rate at which this occurs is to some extent dependent on the rate at which heat is dissipated. Mr. Bucher's explanation also involves the rate of heat dissipation, inasmuch as it would govern the rate at which the air is expanded and hence the degree of quenching obtained.

Answer to Question 3.—It is claimed that the mis-tuning of the open and closed circuits facilitates the quenching action, and since tightening the coupling involves a higher rate of energy transference from one circuit to the other, one would naturally expect the quenching action would require to be stimulated.

Question 4.—What determines the amount of magnetic leakage in a charging circuit (alternator, or alternator and transformer), and why?

Answer.—Your question is rather vague. If you mean what factors in the design govern the magnetic leakage the subject is too lengthy to enter into here and we would refer you to some textbook dealing with design of dynamo electric machinery. On the other hand, if your enquiry relates to the amount of magnetic leakage required in a charging circuit, we would point out that since the condenser being charged acts as an energy reservoir tending to produce a current lead, magnetic leakage acts in the opposite direction and tends to produce current lag, and thus counteracts the effect of capacity in the charging circuit.

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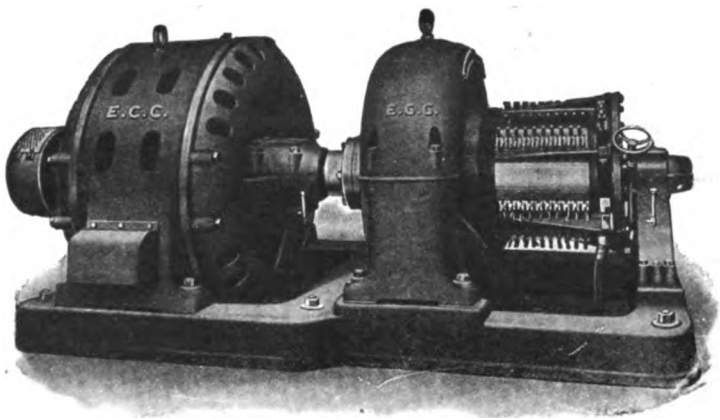

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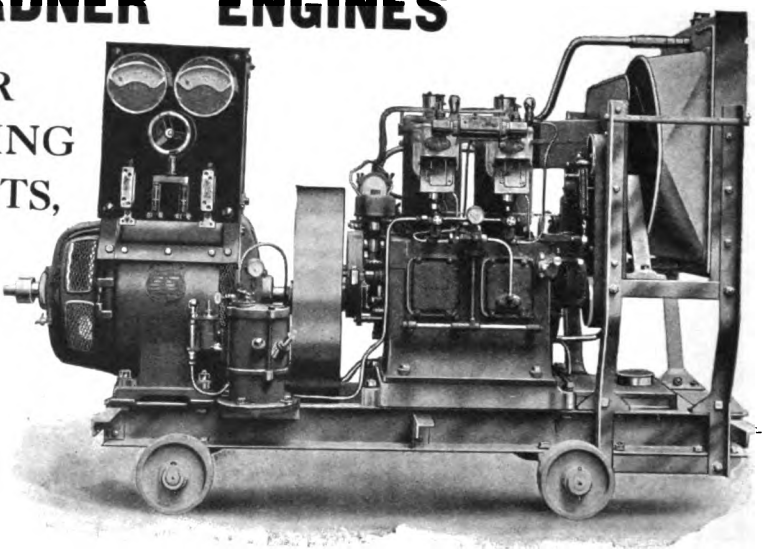

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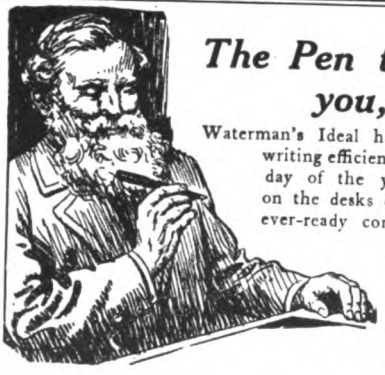

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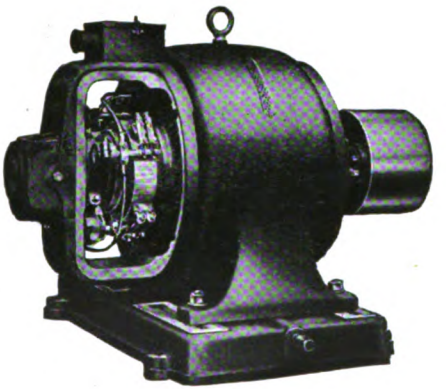

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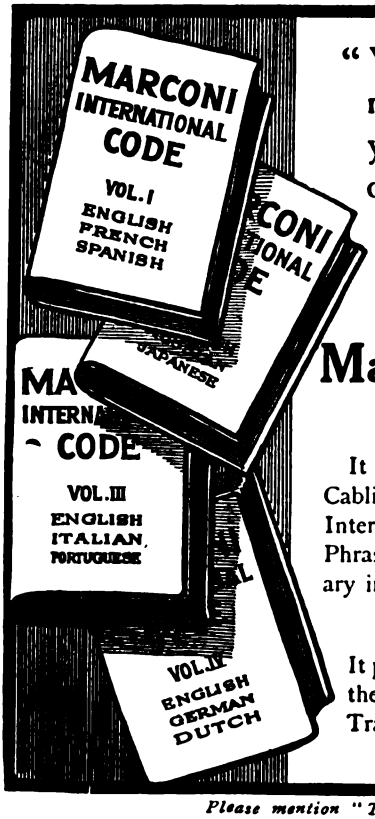

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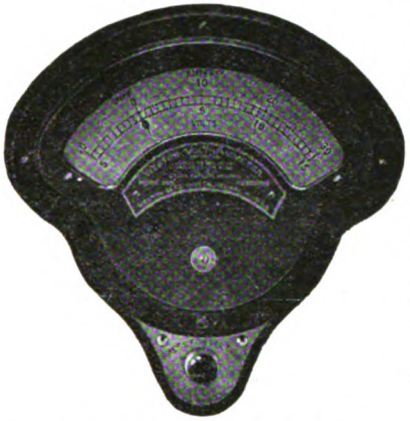

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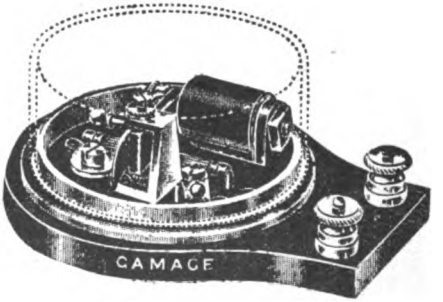

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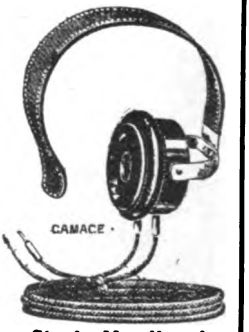

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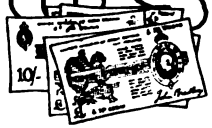

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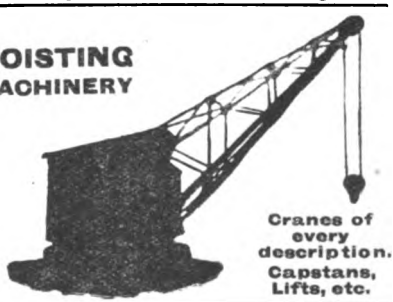

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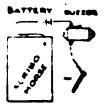

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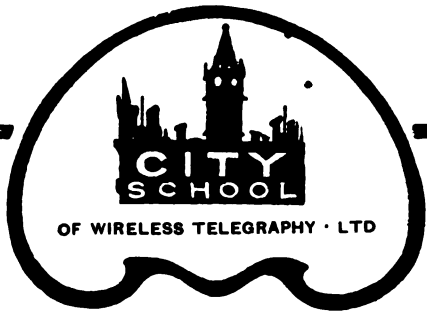

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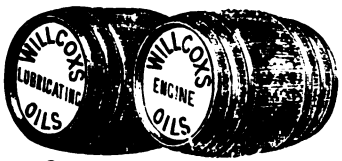

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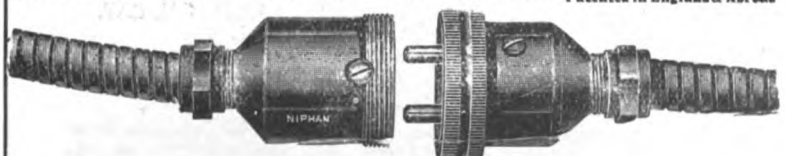

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